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FAO — The Food and Agriculture Organization of the United Nations — grew out of a United Nations Conference held at Hot Springs, Virginia, U.S.A., in May 1943. The nations agreed to work together to secure a lasting peace through freedom from want. The Organization was formally founded at Quebec, Canada, in October 1945. It was located at Washington D.C. until 1951 when the Headquarters office was moved to Rome.

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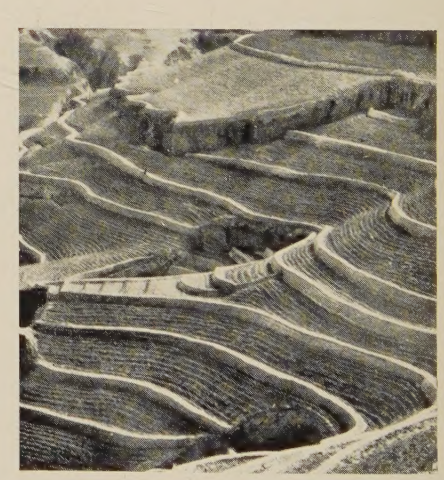


Cover Photograph: *A first stage in the terracing of eroded hillsides in northeastern China. An entire slope is cut into steps by manual labor. The embankments are progressively heightened and the area enclosed between each step is gradually made horizontal. Loess soil is very erodible and the terraces may at first be easily swept away by heavy rain.*

Courtesy, Chinese Ministry for Water Conservation

Unasylva

An International Review of Forestry and Forest Products

FIRE TESTS AND BUILDING CODES

BUILDING codes impose rather rigid restrictions on the use of wood in housing and construction. Both timber and wood-derived products react in varying ways to fire, depending on species but also on the size and form of the product. Furthermore, methods of treatment are employed today on a commercial scale that render wood products resistant to fire to the extent that they will not burn except when directly subjected to an external source of heat, and they cease to burn or glow as this source is removed. There is therefore now much reviewing and rewriting of building codes with respect to fire hazard. Codes should be based on the actual performance of a specific material and any requirement that a material should have particular inherent properties is not consistent with modern technological methods available for protective treatment of materials. This was the view expressed by the experts attending the Fourth FAO Conference on Wood Technology at Madrid earlier this year.

The exceptional fire resistance of heavy timbers is a well established fact. Less known are the possibilities that exist to improve the fire resistance of wood structures by adequate design and planning. Two examples will illustrate such possibilities. In Canada, the fire insurance losses in wood frame houses are lower than in other dwellings. This is due to the appropriate design of frame houses and has been recognized by a reduction in insurance rates. The second example refers to the fire resistance of wooden doors. A few years ago wooden doors manufactured in the Netherlands had a maximum fire resistance of 10 minutes in a standard test. Today, Dutch manufacturers are able to produce wooden doors with a resistance of 40 to 60 minutes.

There are thus considerable possibilities for improvements of the behavior of wood and its products in relationship to fire. To further such improvements, satisfactory test methods must be developed. The growing importance of fire research and fire test methods has been acknowledged for some time. Many factors affect the progress of actual fires in buildings and structures and the difficulty of simulating all of them in a single controlled test is the main reason why a number of different test methods are used to get information on various specific aspects of fire behavior.

At the Madrid Conference on Wood Technology, it was emphasized that any method of fire testing should lend itself to the evaluation of the behavior of all types of materials during a fire and that there was no need to develop specific methods for wood and wood-base material except possibly in cases where research in the development of improvements in fire protective treatments were involved.

There is immediate need for a test which does not require extensive space and expensive auxiliary equipment. Three lines of approach in the development of testing equipment are discernible. They are:

(a) tunnel tests;

(*b*) box tests;

(*c*) radiation panel tests.

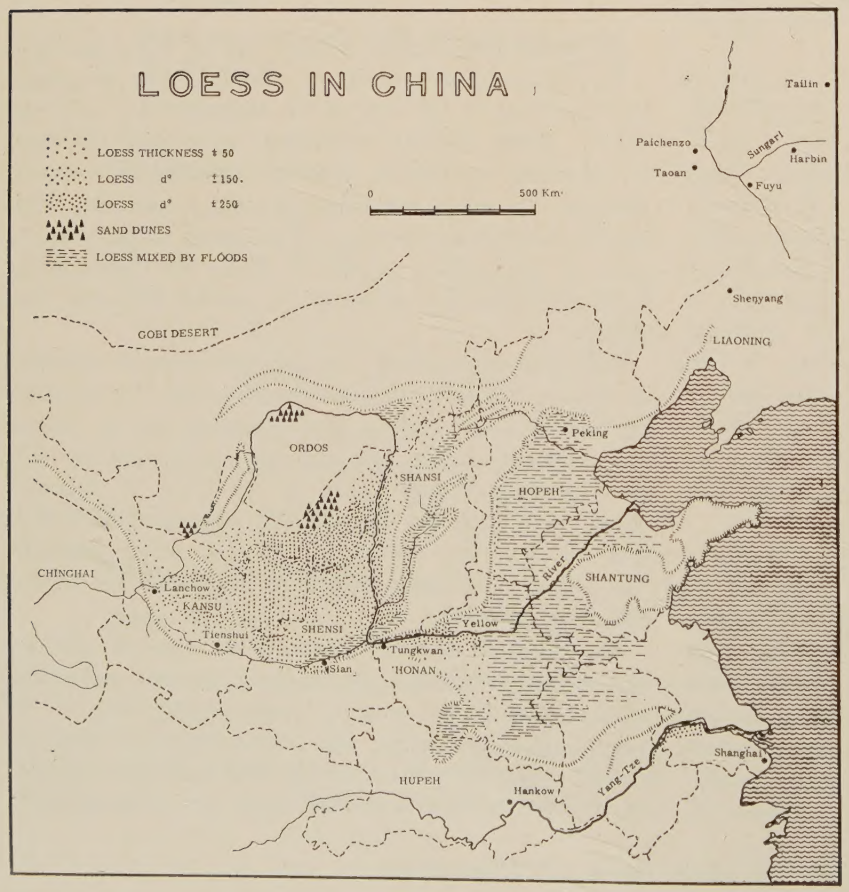
No preference is given to any one of these methods.

In evaluating the results of a test, it was recognized that reaction to fire cannot be expressed by only one index. While building authorities may wish to resort to simplified expressions, it is not sufficient for research purposes to grade materials in such a manner. It is therefore necessary to report all pertinent measurements, such as ignitability, spread of flame, fire penetration, heat producted by combustion, smoke intensity and others.

This does not exclude the differentiation of materials in classes, whether such grading be done by calculating indices from certain measurements or by setting limits inside which temperature curves should fall. Such grading should apply to all types of material which constitute the fire load in a room or building, that is, furniture, curtains, rugs and other contents. The testing apparatus should be adaptable for testing also such materials.

The ultimate aim is to reduce the number of tests to a select few which could be given international recognition. This is not possible at the present time in the opinion of most experts, who recommend that emphasis should rather be placed on insuring that test methods are directed towards a realistic appraisal of fire hazards.

This is the fiftieth issue of *Unasylva*



FIGURES 1 and 2. – *Maps showing, respectively, the political divisions and the incidence of loess erosion in China. All illustrations for this article are used by courtesy of the Chinese Ministry for Water Conservation.*

Forest Rehabilitation and Soil Conservation in China

Jean MESSINES
Inspecteur-Général des Eaux et Forêts, Grenoble

China covers over 9.5 million square kilometers – an area equivalent to that of Europe or of the United States of America. A country of such immense size will clearly show considerable diversity both in the physical condions of soil and climate and in the circumstances of human life. As a member of a French Economic and Technical Mission, the author spent only six weeks in the Chinese People's Republic during September and October 1957, a stay too brief to acquire more than a general picture of the country's forest economy and soil erosion problems. This article therefore draws freely on information supplied, in their offices and in the field, by foresters, agricultural experts and water engineers engaged on afforestation and soil conservation projects.

According to the latest figures of the Ministry of Forests, China's forested area covers 76,600,000 hectares, a proportion of only 7.9 percent of the total land area.[1] The total volume of growing stock is estimated at 5 thousand million cubic meters, i.e., an average of only 65 cubic meters per hectare. These figures are provisional because a detailed inventory of forests has not yet been completed.

But clearly China is inadequately forested. During the former Empire, the forest cover was progressively destroyed and steps were rarely taken to restore it. Uplands were usually denuded. It is considered that, in historical times, 300 million hectares — 30 percent of the land area — were deforested. As shown later, continually increasing erosion still ravages over half of these lands today, denuding 160 million hectares.

This deforestation affects some provinces much more than others. There are still some fairly well-wooded upland regions. For example, the province of Szechwan is still 30 percent wooded with 13,300,000 hectares of forest; for Yunnan, the figures are 23 percent and 10,700,000 hectares. The provinces of Hunan and Fukien in the tropical zone are respectively 19 percent and 18 percent forested. The most extensive forest area is that of the uplands of north and east Manchuria: this covers 20 million hectares and is China's main source of commercial timber — about 2,400 million cubic meters. Of the three Manchurian provinces, the best wooded is Heilungkiang. Its 460,000 square kilometers, almost as large as France, includes 13 million hectares of forests and 1,600 million cubic meters of standing timber, mainly coniferous — about 120 to 125 cubic meters per hectare. This is not very much considering that these moderate uplands with their cool damp climate are natural forest lands, but the stands have been seriously affected by wartime felling and by fires.

[1] Compare "Forestry in China", *Unasylva*, Volume 2, Number 6, page 304.

Forest types

The forests stretch from the cool and warm temperate zones to the tropical zone and are of very different types and include a great variety of species.

More than 5,000 woody species have, indeed, been recognized, among them about 2,000 forest trees: in all, 700 genera and 130 families. More than 50 species are specific to China, notably such coniferous species as *Cunningham lanceolata*, *Pseudolarix amabilis*, *Metasequoia glyptostroboides*, *Glyptostrobus pensilis*, *Pinus bungeana*... or deciduous trees like *Eucommia ulmoides*.

The typical tree of rural China is a willow, *Salix matsudana*. In the parks on the outskirts of Peking, the visitor can soon identify *Ginkgo biloba* and *Juniperus chinensis*, *Pinus tabulaeformis* even on farms and, as well as *Sophora japonica*, *Ailantus altissima* and an elm, *Ulmus pumila*, found widespread from north to south. Finally there is the robinia (false acacia) which seems to grow everywhere.

The forest landscape in Manchuria has a familiar look to a Western forester, for he finds there a forest of temperate type, dormant in winter, containing numerous deciduous species, such as oak, ash, maple and especially poplars, aspens and birch, as well as various coniferous trees, i.e., firs, spruces and particularly pines and larches. The genera are identical but the species are generally not the same.

Somewhat similar types of forest are found in the other mountain regions of north and northeast China, especially in Inner Mongolia. In Sinkiang (Central Asia) the high mountains of Tienchang encompass imposing glacial formations, pine forests and Alpine-type pastures.

The temperate-type forest merges almost imperceptibly into tropical forest. Central Asia excepted, there is no desert zone, nor Mediterranean zone either. From north to south the relief offers only slight barriers and there are no internal climatic frontiers. This explains the interpenetration of the most cold-resistant

tropical species and the most heat-resistant temperate species. Moreover, there is, almost throughout China, a happy combination of summer heat and rainfall as a result of which the forests are rich and varied wherever man has not spoiled them.

The hot wet regions of the south and southeast conserve the remains of a truly tropical forest consisting of a few emergent fast-growing species amidst a closed canopy of evergreen trees.

On the way from Hong Kong to Canton one sees a monotonous succession of hills either deforested or carrying open stands of *Cunninghamia lanceolata*, *Pinus massoniana* and *Pinus kwangtungenis*. Elsewhere, there are stands of coniferous trees of the genera *Cephalotaxus*, *Podocarpus*, *Keteleria* or *Cryptomeria*, and deciduous trees of the genera *Liquidambar*, *Dalbergia*, *Albizia*, *Phoebe*, *Lithocarpus* or *Castanopsis* and, apparently, very strange mixtures of these species with others of more northern character, chiefly oak, ash, chestnut, lime, elm and walnut, not to mention innumerable species of palm and bamboo. The latter constitute degraded secondary formations already far removed from the climax forest.

This subtropical type of forest takes on an increasingly mountainous character in southwest China as one leaves the southern plains and hills. The formations are often bushy, but there are still fine forests of the original type in the upland regions. Among the coniferous species to be found in them are *Tsuga* and *Pseudotsuga*, *Abies delavayi* and *Picea likiangensis* (the last two species being specific to Yunnan and Szechwan), *Cupressus funebris* and numerous species of pine: *Pinus armandii*, *P. massoniana*, *P. yunnanensis* and *P. insularis*. The deciduous trees consist of oaks, maples, *Castanopsis*, *Lithocarpus*, *Phoebe*.

It is not easy to say how far man and how far natural factors are to blame for the degraded state of the forests. Admittedly, the writer noted several times during his journey the serious damage caused to forests by excessive grazing, wilful burning by shepherds, and abusive cutting and felling. But in many cases neither man nor his livestock can be held responsible for the situation.

It is almost certain that China has never been completely covered by forests. The northern part of Shansi and Shensi provinces in northwest China — especially in the loop of the Yellow river — and several fairly flat regions of Mongolia or Chinese Turkestan can never have been wooded — at least in historical times. The extreme aridity and the dryness of the soil aggravated by its impermeability, would not permit any plant life but that of steppes — and the latter cover considerable areas.

There are, however, transition formations between forest and steppe: scrub or shrub formations. This *maquis* landscape is very widespread in many mountain regions of China. One soon becomes aware of this when journeying, for instance, in the mountains northwest of Peking or when flying over the provinces of Shansi and Shensi between Peking and Sian or between Sian and Lanchow. It is rather difficult to divide the blame between physical and human factors for the present degraded state of these uplands. The phenomena are complex and their development differs from region to region. Man's occupation has left its traces of destruction but drought, wind and winter frost, together with the sterility of some lands, are undoubted obstacles to the establishment of forest.

Erosion - its Extent, Causes and Effects

Chinese experts estimate that the phenomena of degradation are apparent over about one sixth of the country's total area, i. e., 1,600,000 square kilometers or 160 million hectares. The area most affected (about 580,000 square kilometers in all) is the basin of the Yellow river, especially within the huge loop of that river. Next comes the Yangtze or Blue river basin (160,000 square kilometers). Then there is an affected area of 130,000 square kilometers in the Peking region, in the mountains to the northeast of the bend in the Yellow river; and 75,000 square kilometers in the basin of the Hwai river, etc.

It stands to reason that erosion will show the most varied manifestations in China, given the size and range of the country. Among the most dangerous climatic factors are the frequent and violent sandstorms and the alternations of frost and thaw.

Another cause of erosion is, of course, the varied relief of the country. China is very mountainous as the following figures show:

	Elevation in meters	*Percent*
Plains, hills and low mountains	under 500	15
Medium uplands	500-1,000	20
High mountains	over 1,000	65

As for geological conditions, the abundance — indeed predominance — of sedimentary rocks (e. g., marine facies of sandstone, clay and sands resulting in soft hilly relief) aggravates the action of erosion. The deep recent quaternary deposits such as moraines, superficial glacial deposits, and river gravels and alluvium and lastly — and above all — loess, furnish inexhaustible matter for erosion.

Finally, in China are found all types of natural erosion — climatic, topographical and geological — which some writers call normal erosion, and all types of accelerated erosion, i. e., degradation heightened by human occupation which manifests itself in clearing, grazing and burning, resulting in the destruction of forest cover, the formation of torrents and the degradation, even disappearance, of the soil. There are, however, two kinds of erosion especially widespread in China.

Continental wind erosion

Vast areas, mostly of even relief, lying in the loop of the Yellow river, and especially north and northeast of that loop; the farming or semifarming steppe-like plains of Manchuria, of Inner Mongolia and of Kansu;

FIGURE 3. – *General view of bench terraces along the middle reaches of the Yellow river.*

these regions are subject, over long winter periods, to winds of extreme violence. These lead either to the formation of local river and continental *dunes* such as we saw along the Yellow river and the Sungari river, or to a general surface erosion affecting millions of hectares of steppe land, destroying the soil or its fertility.

The conservation of these soils and their development for agriculture calls for defence works to break the force of the wind. The methods proposed will be dealt with later.

Erosion on loess

The area covered by loess is 600,000 square kilometers — a vast loess " domain " covering a sixteenth part of China.

Loess is the primary cause of the more serious phenomena of erosion and flooding which occur in China. In the region we have mentioned, the slightest depression, all plains and most of the hills and low mountains are, as it were, drowned in loess.

The loess is a geological formation of the quarternary epoch, the result of winds. This wind erosion has continued for thousands of years and still goes on today during certain winter periods although much less acutely than formerly. It has stripped enormous desert areas in the steppes of Central Asia, Tibet and Mongolia, carrying off billions of tons of sand. This sand has piled up in the river basins and lower plains, forming thick deposits of continental sediment. While it is the basis of the farming wealth in these areas, this sediment is at the same time a terrible threat insofar as it remains a cause of erosion.

The loess is a grayish yellow silt, the grains of which are finer than sand (less than 0.05 millimeters in diameter) but larger than clay (over 0.005 millimeters in diameter) and often include fine but sharp fragments of rock which are not smoothed by running water. This fact and the fineness of the grains throughout the deposit prove its wind origin. Nevertheless, pure loess is often mixed with river alluvium. This is usual all over the great eastern plain where flood waters have beaten together and mixed up the wind silt from the tablelands with the river silt before depositing them in thick layers on the immense lower basin of the Yellow river, which is truly China's granary.

Seen from the air, this great cultivated plain, where it reaches the mountains west and northwest of Peking, looks like an immense sea of river alluvium filling a vast lake or marine depression to a depth of some tens or hundreds of meters and showing a very clear demarcation line where it touches the uplands. It is now known, however, that it consists of loess deposits transformed by stream flow; in short, of transported matter of diverse origins.

In mountain regions, loess carpets the valley bottoms and coats with varying thickness the lower and middle slopes of the mountains. Sometimes it even " clothes " the whole of the relief — including summits — with a continuous mantle, smoothing over contours and dulling the sharpness of land features. Usually the deposits are some 50 to 60 meters thick, but they often reach 150 to 200 meters and at the most 400 meters. Such an accumulation of friable matter offers an ideal subject for erosion.

The base of the loess layers is often associated with sands which in their turn lie on gravels. This arrangement indicates the sequence of deposits: first of gravels, then of sands, and lastly of loess.

The loess is soft and porous. In the mass it behaves like permeable rock. It is easily channeled and shaped. Acted upon by atmospheric agents, the loess crumbles apart causing vertical-walled ravines — a consequence of the material's permeability and cohesion without hardness. Hence it can be easily shaped by men into descending terraces like giant staircases: and

FIGURE 4. – *A system of terraces on the lower slopes of mountains in the loess region.*

such cultivated terraces make up a landscape typical of all the loess mountain regions of China.

Unfortunately the soil is overpermeable, and the climate is somewhat arid. These physical disadvantages have been worsened by the methods of farming the soil; for men have not so far — through ignorance or inability — added sufficient quantities of those organic manures or nitrogenous fertilizers which would have bound the soil. Hence the land lacks consistency and resolves into impalpable dust.

Linear torrent erosion

The loess mountains are, firstly, subject to linear torrent erosion. Deep narrow ravines are formed down the slopes, starting with stream runnels in the vertical edges of the terrace. In some cases this takes place through a collapse of the walls and mass falls, so forming muddy torrents. There is a magnificent example of this last phenomenon on the stretch of railroad from Paoki to Chengtu on a slope overlooking the Kwaling, a tributary of the Yangtze-Kiang.

Surface erosion

These mountains are also the scene of surface erosion affecting the whole of the cultivated top soil through the action of run-off and wind. All the processes of degradation classified in text-books appear:

(*a*) sheet erosion or general stripping of top soil;
(*b*) rill erosion;
(*c*) gully erosion where the rills run into the torrent-ravines.

If the slope is gentle, as with certain softly undulated plateaus, then the ravines formed in the loess may not empty into the river. In this case, they are seen as ditches with more or less scalloped edges but always steep-walled. Since the water cannot get out, it soaks into the subsoil.

These ravines and torrents, whether or not they flow into a river, usually develop as follows. They widen through the gradual retreat of their banks which collapse in vertical slabs. In this way the bed becomes an ample plot which very little ingenuity can transform into a flat-bottomed bowl. Into this crops can be reintroduced — even the finest crops since they are usually irrigable. One even sees farms or small villages established in these " bowls ", by no means one of the least surprising things about this disconcerting loess " domain ".

Where the slope is steep, the torrents gouge out deeper gullies, scoring the whole slope and draining off the water to the downstream watercourse. It may also happen that, when the ravine has completed its development, it may be widened sufficiently to enable crops to be sown but, on account of the steepness, the crops must be grown on mounting terraces linked by steps. In this case, erosion often continues in secondary ravines branching off from the more or less steep banks of the main ravine.

This erosion, despite its extent, does not seem particularly dangerous on the site where it actually takes place. There are no regions more intensely cultivated and more densely populated. Flying over Shensi, one sees up to five or six villages per square kilometer, of an estimated density of 800 to 1,000 inhabitants. The supply of loess is inexhaustible and the gullied soil can be reshaped and brought into cultivation again.

The real harm occurs elsewhere in the lower plains and on the Yellow river delta, in a countryside still more densely populated than the plateaus and mountains of loess.

And the harm done is in essence measurable by the solid matter carried by the Yellow river. According to reports this has reached the seemingly incredible weight of 2,643 million tons per year. Chinese engineers estimate its average content at 1,380 million tons. They have worked it out that the annual bulk of solid matter carried by the Yellow river would make a one meter solid dyke stretching 23 times round the earth. By comparison, the solid content of the Seine at Paris is paltry — a mere 600,000 to 700,000 tons yearly.

Specific degradation

The specific degradation (i. e., the amount of solid matter per unit of area) is 1,800 tons per square kilometer per year for the whole of the Yellow river. Applied to a basin 745,000 square kilometers in area, it is without doubt a world record. But this specific degradation is especially severe around some tributaries in the Yellow river loop, right in the midst of the loess country: 5,800 tons for the Weiho river, and 7,190 for the Loho river. This last figure means that the overall stripping of surface soil in that basin is over 7 millimeters per year. By way of comparison, in the Alps, the specific degradation on some large torrent basins rarely reaches, 1,500 tons and, on the average, does not exceed 100 tons.

Specific turbidity

The amount of solid matter per unit of weight, or the specific turbidity, on the Yellow river delta averages 44 kilograms per 1,000 kilograms of mixed water and mud, and reaches a maximum of 430 to 460 kilograms. But a greater degree of specific turbidity has been observed in numerous tributaries of the Yellow river. The measurements and tests carried out on this subject by several hydraulic experts and particularly by the Norwegian engineer, Mr. Eliassen, are extremely interesting. A specific turbidity of 500 kilograms is almost a load limit. In the Yellow river it is made possible by the fineness of the material. According to Eliassen, with a load of 560 kilograms, the muddy current becomes " plastic " — it congeals. But this observer himself noted that, carrying 510 kilograms, the flow could still be rapid.

Such observations are valid for the Yellow river and can be adapted to the conditions noted on the Weiho and the Chinho rivers with a given slope of the river beds and given current speeds.

A further observation by Eliassen is worthy of careful note: that excessive content of very fine loess mud causes an acceleration of flow. Irregularities on the river bed are smoothed out, accelerating flow. Where a river carries larger elements, which are deposited on the bed and constantly shift in position, the flow is decreased.

As a result of these phenomena the beds of the great rivers are raised and millions of hectares of cultivated plains are constantly threatened by overflow and flooding.

On their lower reaches, the beds of the Yellow and the Yangtze-Kiang rivers are raised sometimes ten meters above the level of the plain. The rivers are contained by embankments representing billions of cubic meters of earthworks. Breaches in these dikes in the past have caused horrifying disasters with victims by the thousand and hundreds of thousands.

Silting-up of dam reservoirs

There is nowadays another problem of equal urgency: the silting-up of the reservoirs of the great hydroelectric dams. This silting-up is taking place at such a rate that the duration, and hence the efficiency, of the constructions are jeopardized. Apart from the decrease in energy output, it is feared that the irrigation network will soon be affected and so the beneficial effects of stream control will be annulled: in other words, floods will again take place.

Thus the Kwanting dam, the first great earthwork constructed by the Chinese from 1951 to 1954, is threatened with complete silting up in about 60 years unless reforestation plans are set on foot at once — although the reservoir's capacity is 2,270 million cubic meters. The still more grandiose Sanmen scheme is for the building of a concrete dam 90 meters high, with an artificial reservoir holding 36 thousand million cubic meters. Working on specific degradation or specific turbidity and other data, there are various ways of working out the speed of silting up in cubic meters per square kilometer per year. All such calculations have a large element of uncertainty: there are, in fact, several hypotheses regarding, in particular, the possibility of drawing off through sluice gates, the effect of the density of solid materials, and on the relative speed and completeness of silting. The degree of compactness in deposits does, indeed, vary with the weather.

Estimates are therefore unreliable. But, despite this, one fact is certain: that the life of the Sanmen reservoir — unless measures are taken to combat silting — will be a mere half-century or so. And, under such conditions, the project would be a failure.

Energetic measures must therefore be taken in all fields: in agriculture, forestry and animal husbandry, as well as in engineering.

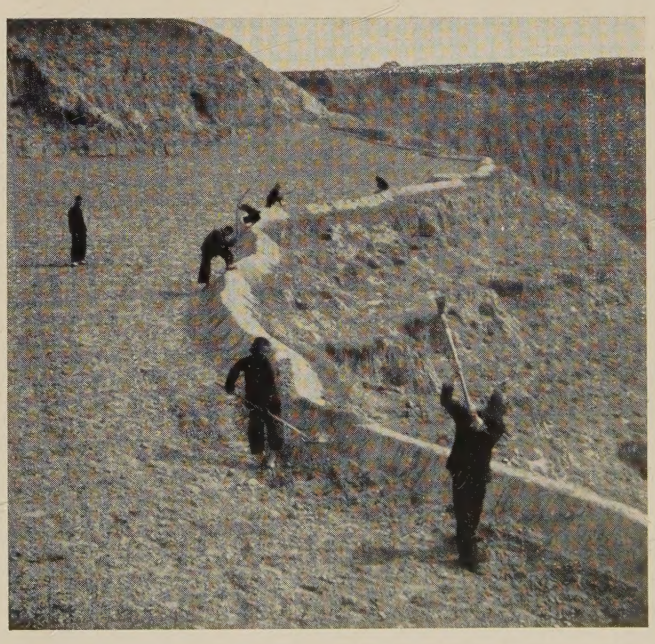
Rehabilitation Works

The best ways of combating erosion are through conservation, re-establishment or extension of a vegetative and forest cover. First priority goes to afforestation and dynamic forestry programs.

Since the Chinese People's Republic was formed in 1949, these principles have been given recognition in governing circles. The Consultative Assembly has several times proclaimed the desire to " defend the forest " and the intention to carry out thoroughly a policy of rigorously planned forest reconstitution and planting.

Such a policy has, of course, fewer obstacles to surmount under a communist than under a liberal regime. One of the first acts of the present regime was to declare, and to set down in the Chinese People's Charter, that, agreed exceptions apart, the natural forests, unexploited

Figure 5. – *The construction of the first retaining walls in making a terrace system.*



bare mountain lands and lowland steppes were the property of the nation.

On this clear foundation, it was easy to develop a forthright forest policy. The First Five-Year Plan (1953) includes a whole program of forestry projects, phased according to the means available at the time and designed in the light of these two requirements:

(*a*) The need to cope with the huge timber requirements of a country undergoing industrialization: timber for housing, offices, factories, public works, hospitals and institutes. Hence the first objective is increased timber production

(*b*) The need to restrain — wherever it cannot be halted — the degradation of land, with the hope of preventing floods and the loss of agricultural land. Hence the second objective is a fight against erosion.

These are two distinct objectives but the action to be taken is the same for both: the reconstitution and improvement of natural forests on the one hand and on the other, planting and creating new forests. Both activities can be conducted simultaneously in varying proportion according to the geographical situation, and the physical and social environments.

These basic ideas — impelling forces as much as ideas — have apparently had a powerful appeal if not to the masses at least among the party leaders for, in answer to a call from the Chinese Central Communist Party, a new twelve-year plan was drawn up in 1956 "to make China a green country".

Starting off from the same point as the First Five-Year Plan, this new program envisages the afforestation of 92 million hectares in 12 years. Since there are 76.6 million hectares of natural forests, the new and old forests together would make up a forest domain of 168.6 million hectares by 1965. The proportion of forested land in China would rise from 7.9 to 19 percent.

Such a goal might seem impossible of attainment in so short a time. The results already obtained, however, make for optimism. By the end of 1956, the fourth year of the First Five-Year Plan, the forestry targets were, it is claimed, exceeded by 70 percent, and were expected to be more than doubled by the end of the five years.

Natural Forests

The improvement of natural forests means in many cases the complete reconstitution of stands which calls for a whole series of measures and operations.

Surveys

The national forest survey is almost completed. Detailed and fairly accurate records have been compiled about the kinds of species and forest types, and the age and assessed volume of the various species. From these data forest maps have been drawn delimiting the forested areas, dividing these up into individual forests, the forests themselves into series, and the series into compartments of which the composition is known with some accuracy.

Obviously these management maps could not be expected to show all the detail and variations as can be done for forests in countries of central and western Europe that have a long forestry history. One map examined was of a forest in Inner Mongolia of 138,000 hectares. The scale was large, 1/50,000, but the forest had nevertheless been divided into compartments of 100 to 200 hectares. It had been possible to mark the chief species making up the growing stock: larch, oak, birch (two species) and poplar. Average diameters were shown, classified as under 40 centimeters, 40 to 60 centimeters, 60 to 80 centimeters and over 80 centimeters. Each species was represented by a certain color, the tint being graduated from light to dark according to the dimensions (i.e., age) of a stand.

The Ministry of Forests gives these figures in regard to the stage reached in these operations as at the end of 1956:

	Area	*Million hectares*
1.	Delimited and divided by Russian inventory methods, ground survey by strip sampling, combined with aerial surveys	20
2.	Covered by aerial survey alone	19
3.	Remaining to be surveyed	38

In Manchuria, the forests of Kirin and Heilungkiang provinces have all been reserved and surveyed. Field work has been completed, and maps are now being made and working plans compiled.

Forest protection

Grazing. In the forest, grazing is now controlled. In most provinces it is, in theory, forbidden altogether but in practice is tolerated in many ways.

In any case, forest grazing, insofar as it can still be practiced since land collectivization and the setting-up of farm production co-operatives, is much less dangerous than formerly. Grazing rights exercised by individuals almost always in the past ended in abuse. Today, individuals cannot with profit act against the collectives. The Cooperative Management Committees are responsible to the forestry authorities and can only act in agreement with them.

Fire. A major scourge of the natural forests of China has long been, and still is, fire. The steps taken to institute a degree of control are, however, noteworthy and should soon begin to show results. First emphasis was laid on propaganda and mass education. At the same time, fire-fighting teams were organized to be ready for prompt and effective action. An alarm system is now efficiently organized with weather stations installed in the forests, lookout towers, telephone networks, and air patrols, etc. The clearance of under-

FIGURE 6. – *The fight against gully erosion. A double wattle-fence dam with a backing of stone.*

growth on firelines, the opening of access roads, and the digging of firebreak trenches goes on steadily every year.

Pests and diseases. Measures for protection mainly through chemical treatments, have been widely introduced.

Forest exploitation

Even though the inventories have shown that the volumes of standing timber per hectare are low, the strong internal demand for timber set against the fact that financial restrictions preclude importing large amounts of foreign timber, results in a rate of cutting which is on the whole heavy. But this applies only to the more accessible areas and there are huge forest tracts, difficult of access, because of rugged terrain, remoteness and absence of means of communication, which remain untouched.

Cutting operations are, generally speaking, difficult everywhere because of lack of satisfactory road networks. The usual practice is therefore clear felling, to be followed by artificial regeneration. Since 1953, 249,000 hectares of clear-cut state forest have been replanted. Chinese foresters do not ignore the fact that clear felling is often indicative of primitive silviculture, and they have tried out in some forests various systems of progressive or selection felling. The results to be seen in the Tailin forests in Manchuria give no clear conclusions. For lack of extraction facilities, trees felled under a system of selection cutting may lie to rot on the spot.

In the present state of things in China, it is premature to expect the application of intensive silvicultural methods. The methods practiced in Manchuria suit the situation: clear-cutting, skidding by means of cables, winches, and tractors, and transport by forest railroads; then artificial reforestation after cutting, planting up of blanks, and the introduction of conifers into natural deciduous stands.

FIGURE 7. – *The Experiment Station for Water Engineering Research at Tienshui. Installations for measuring the specific degradation of soils are seen.*

Equipment

Equipment is the forest's " infra-structure ". When complete, forest utilization can be practiced in the best way both from the point of view of economics and silviculture. It facilitates protection, control and, in short, good forest management. By equipment is meant all that goes to make a forest workable, houses, roads, extraction lanes and paths, storage points, telephone lines, cables, machines and railroads.

The first equipment programs in China have chiefly been concerned with road building. At the end of 1956, 5,700 kilometers of new forest roads had been constructed.

This is entirely commendable. It may be mentioned that one of the most spectacular achievements of the National Forestry Fund in France — and doubtless one of the most profitable also — has been the construction of forest roads, chiefly on behalf of mountain communes. Obviously, Chinese foresters have identical problems and identical objectives in view. For instance, the Chief of the Forest Service at Harbin who controls the forests of Heilungkiang Province with an area of 46 million hectares — nearly equal to that of France — proposes to carry out an ambitious program of forest road construction on the 13 million hectares of state forest.

The first item on this program is a network of " permanent communications " i.e., access roads open to traffic all the year round. It is planned to build 2,000 kilometers of such roads in the six years from 1956 to 1962: 300 kilometers had already been built up to the end of 1956. The average cost, comparable with

that in France, is about 30,000 yuans, roughly $14,300, per kilometer in mountain country. The second part of the program envisages a network of 9,000 kilometers of secondary roads for temporary use, passable for trucks during fine weather but closed to traffic during the winter.

Afforestation

Chinese foresters began major planting programs only in 1953, but already they have attained considerable results. In the four years 1953 to 1956 inclusive, 10.3 million hectares were planted, according to the official statistics of the Forest Ministry. Of this total 6 percent represents planting by the state and 94 percent by co-operatives. One is immediately struck by the claim that by far the greater part of the work has been carried out by the peasant collectives.

The statistics further detail the types of plantations:

	Thousand hectares
1. Afforestation for timber production, including the reconstitution of natural forests entirely destroyed	4,700
2. Afforestation for protective purposes, partly associated with hydroelectric works. Afforestation of denuded uplands and sand-dunes. Shelterbelts	2,640
3. Afforestation for special produce, tanning barks, cork, essential oils, essences and varnishes	1,900
4. Fuelwood, bamboos, etc.	1,020
Total	10,300

As already mentioned, by the end of 1956 the expectations of the First Five-Year Plan had already been exceeded by 71.7 percent. The Province of Kansu had replanted 345,000 hectares, three and a half times the area had envisaged in the plan. In Szechwan, 460,000 hectares been planted, including notable large-scale plantations of tung (*Aleurites fordii*) which yields a most valuable varnish base. The three Manchurian provinces, competing with one another, planted 1,200,000 hectares altogether in four years.

One could go on quoting examples from the official statistics. All the provinces are embarked on these planting programs which grow each year. There are, however, only eight years of experiment and trial to call upon. The work is only just beginning and very many of the operators lack experience. Hence the quality of the plantations, as the responsible managers themselves admit, is not always of the best. While the successful plantings may reach 90 and even 100 percent in some regions (chiefly in the case of state plantations which are always more successful), the average is only 60 to 80 percent.

Tree planting techniques are improving each year — although they present a definite problem. Methods vary from region to region according to soil and climate. Practical planting manuals are being compiled by the Forest Ministry in Peking. They cover choice of species and planting methods, whether by direct seeding or transplants, and harvesting, selection and storage of seed, etc. In short, the problems are the same as in other countries.

The remarkable feature of the program in China is the intensity of effort put into it. One cannot but be amazed that in only four years afforestation has apparently raised by over one percent the proportion of forested area in a country covering 960 million hectares. And the pace is increasing.

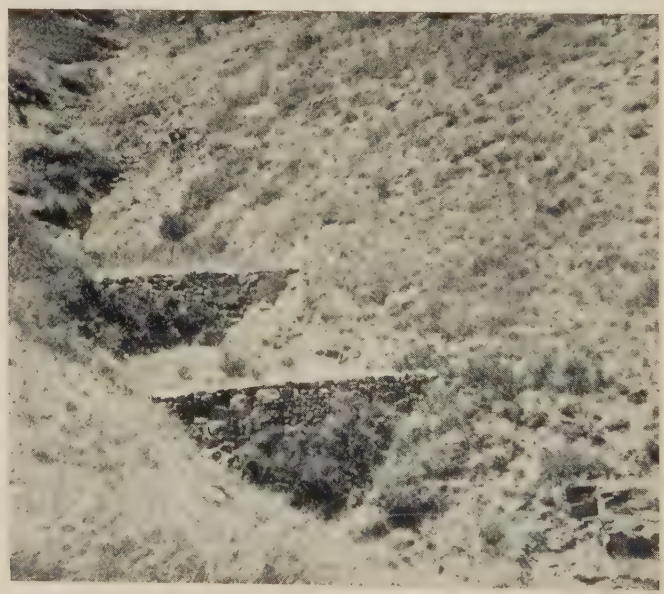
Another remarkable feature is the economical way in which the work is carried out. One must distinguish here between state and co-operative undertakings.

State plantations

State efforts are directed towards the reforestation of degraded natural forests and the afforestation of bare hills and steppe lands unsuitable for crops or man's use.

Figure 8. – *An earth dam against sedimentation, blocking a ravine. The deposits of soil are leveled out and cultivated.*

Figure 9. – *Small dry-stone dams in a gully.*



It has already been pointed out that the State has the right to take over all uncultivated lands where reforestation operations are then carried out as a public service to protect the land against erosion. This situation is comparable to that in countries with a free economy where the State also assumes responsibility for protective reforestation of doubtful financial return.

The state plantations are undertaken by the reforestation sections of local services and increasingly by the state forest farms. These are state agencies specializing in forestry operations. It is to be noted that they were already in existence at the time of the Kuomintang, but they have since increased in number from 60 to more than 400 at the end of 1956 and they are still multiplying. Few of these farms are mechanized — only 5 in the Province of Kirin, for instance, like the one which the writer visited at Taoan and which is engaged in planting shelterbelts.

Planting by co-operatives

It has already been mentioned that the Chinese peasantry has afforested 9,700,000 hectares in four years. The reasons are worth looking at more closely.

Land collectivization was completed in 1957. All villages without exception are organized into co-operatives. In the spring of 1956 there were some 1,800,000 co-operatives but since then they have been concentrated and now number around 700,000. They group 120 million rural families and more than 500 million individuals. These co-operatives are all socialist — that is, the land is held in common and ground rents are abolished. Only labor earns the right to remuneration or wages. Since the Chinese countryside is overpopulated, farm workers rarely if ever find full employment, and it is thus fairly easy to organize groups within the co-operatives to concentrate on particular work — road-making, building, forestry work, etc. This specialization by the peasants in the co-operatives is more or less general, and still leaves a mass of agricultural workers. All receive comparable wages fixed according to "output norms" and chiefly paid in kind, i.e., in shares in farm products.

The co-operative system therefore makes automatically for division of labor and work must be found to be done. It is not therefore surprising that many co-operatives have, even without compulsion, turned to tree planting and even other forestry operations. To be sure, the Government has encouraged the process and employed more or less arbitrary means of persuasion. But in any case, the true interests of the rural populations generally coincide with what the authorities are seeking.

At the outset, the State could give the co-operatives assistance in kind, such as plants and fertilizers, and sometimes (but rarely) financial help to pay workers' wages. Now it only furnishes technical assistance and controls the execution of the work. The latter must conform to broad programs and plans — at least in certain types of operations like the establishment of shelterbelts. The costs borne by the State are today restricted to a relatively insignificant outlay on administration and control. The co-operatives have their own technicians, appointing chiefs to direct their forestry sections. They grow their own tree-plants in communal or intercommunity nurseries.

The system is open to two criticisms:

(*a*) The peasants' spontaneous efforts, even though inspired from above, do not always fit in with the needs and requirements of the overall plan. Operations are often haphazard and unco-ordinated and the results are not from the technical standpoint always good.

(*b*) It may be reasonably anticipated that in the fairly near future the co-operatives will have completed the afforestation of all the communal lands suitable for planting and will automatically have to stop planting and confine work to maintenance alone.

At that stage, the full burden for afforestation work will fall on the State in the regions populated sparsely or not at all, just the crucial areas where erosion offers the worst threats. No doubt this increasingly required intervention by the State will help attain the Plan's objective of spreading afforestation evenly throughout the provinces. But the State will be faced with an ever increasing financial burden. Perhaps this will be proved false because it is not impossible — it is, indeed, quite likely — that agricultural settlement may accompany the afforestation of mountain and steppe land. An agro-silvo-pastoral economy with grazing and timber predominating could transform certain of the borderlands of the provinces of northeast, north, northwest and western China, and even some of the south China uplands. One may see many a youthful co-operative contingent "swarming" victoriously into the virgin territories and founding fresh co-operatives which would then undertake, with state help, all the operations for developing the land — including tree planting.

Technical and financial help from the State will, however, always be needed at the outset, for the Chinese land worker is, above all, a market gardener and crop farmer. His education in stockfarming as in forestry has not yet begun.

A few remarks may be apposite on working conditions.

Wages and costs. Wages in cash are rarely given except for work for the State. Such wages are low, which makes the costs of afforestation cheap. For an ordinary plantation, without cultural treatment but taking into account the value of the nursery-raised plants, the cost is three or four times lower than, for example, in France.

As for planting by co-operatives, the outlay is, one might say, nominal although the Chinese land worker must, of course, live. But all members of the co-operative are jointly responsible, all take part in the work of producing — and in sharing — the products of the land, including ultimately the timber harvest. Notions about costing of work and returns are academic in the

rural economy of a communist country. Afforestation is a national public service usefully undertaken with a peasant manpower always on the verge of unemployment.

Mechanization. It is questionable whether the mechanization of operations is desirable. Mechanization does, indeed, present two contradictory features. On the one hand, the enormous population justifies the use of manual labor and one can understand how great hydroelectric projects, like the Kwanting earthwork dam, have been accomplished with the help of the little baskets of hundreds of thousands of workers. On the other hand, however, the tasks facing China are immense. Even with such a surplus of manpower it can be easily realized that larger-scale works could be undertaken and certain objectives be more speedily attained with the help of machinery.

As regards agriculture, it is surprising to observe — from an aircraft, for instance — that the fragmentation of fields and their cultivation has remained just as it was before collectivization took place. One would have thought that a profound change would have been caused in the structure of agriculture, but the same fields appear to be still tilled by hand or with rudimentary plows within their old and narrow boundaries. A hint of change can be detected with the appearance of several factories making cultivation machines. The Government has ordered and taken delivery of farm tractors, reserved for the present to the more fertile and productive areas. Mechanized state farms already exist or are coming into being.

As for forestry, felling, road construction and certain large-scale planting schemes now demand a minimum of machinery. The existence of a few mechanized forest farms in the Province of Kirim points to a trend towards mechanization, but on a moderate scale. Machines should be almost indispensable for establishing shelterbelts in connection with the development of immense steppe areas as in Manchuria. The uniformly flat country, the distances, and the shortness of the working season justify mechanization, at least for state-run operations.

To sum up then: large-scale afforestation in China is well under way, and has so far been helped by the abundance of manpower, by political and social organization, and by a climate of opinion very favorable to the cause.

Planting Techniques

Nurseries

The Chinese have always had the reputation of being first-rate market gardeners. Forest nurseries are run according to the best horticultural methods. The plants are well tended, raised on a large scale, and a variety of species are grown. There is not only large-scale production of the commonly-used conifers but also a very complete range of broadleaved trees and often shrubs and bushes widely used in China for binding the soil: *Eleagnus angustifolia*, *Evonymus alata*, *Eucommia ulmoides*, various species of *Rhus* and a herbaceous plant, *Coriaria sinica*.

Two lines of research which are being pursued, are worth special mention:

(*a*) The raising of forage species from seed. Many kinds of grasses and leguminous plants, useful for binding degraded soils, at the same time can constitute a productive pasturage. The creation of pasture resources and the development of stock farming are thus allied to the anti-erosion projects.

A similar problem faces the countries bordering the Mediterranean. FAO's efforts in this matter are well known: the setting up, among the countries of North Africa, the Near East and Southern Europe, of working parties on pasture and fodder development and the creation of standard Mediterranean nurseries in which to study and compare ecotypes, i.e., local strains or varieties of grasses and plants best adapted to given soil and climate conditions. The research at present being carried out by the Chinese in several provinces could profit not only by exchange of information with other countries but of study material too.

(*b*) Genetics research and experiments to produce hybrid poplar clones, of the healthiest, most disease-resistant and fastest-growing specimens. These experiments are being carried out at the nursery of the Van-Shu-Shan Forest Research Station near Peking.

Experiments are being tried chiefly with poplars of the balsam group — very widespread in China — crossing them either with other species of this same group or with species of other groups, notably the black poplars. This is a subject of topical interest in many countries of Europe and there has been much scientific advance. It is a pleasant surprise to find China — no doubt on the advice of Soviet experts — deliberately following this line of research. We shall see later, when discussing shelterbelts, the particular interest which this subject may have.

Plantations for timber production

In Manchuria and in the provinces of Kansu and Szechwan, the writer visited plantations of the most varied compositions of coniferous and broadleaved species. The most spectacular results are claimed, however, to be obtained with fast-growing species of eucalypts and poplars.

There was no opportunity to visit any extensive eucalypt plantations, but many species have been tested and widely planted in several eastern, southern and southwestern provinces: Fukien, Kwangtung, Kwangsi, Yunnan and Szechwan. The species giving the best results are apparently *E. robusta*, *E. globulus* and *E. tereticornis* in the south and west, and *E. camaldulensis* and *E. maculata* (var. *citriodora*) in the south.

These and other species of *Eucalyptus* have shown hitherto unsuspected possibilities for planting in China's subtropical zones which are free of acute and prolonged cold spells.

There is no question about the importance of the poplar in the farms and woodlands, and hence in the economic life of China. The evolution of the poplar in the Far East has probably gone through the same stages as in Europe, leading to the remarkable development of a tree valuable for the many uses of its timber. China is rich in all kinds of poplars, especially of the aspen and balsam sections. Moreover, there is a great future for the utilization on an industrial scale of black poplars which are the most commonly used in Europe. In north China, an energetic drive is being conducted to plant more poplars, chiefly in rows along the main highways but also in compact blocks and on drained swampy bottoms in agricultural areas.

Around Peking, the aspect of the countryside is being radically changed by the avenues of white poplars (*Populus alba* and *P. tomentosa*) and black poplars planted along the highways. The rows, often double and triple, also act as windbreaks. Most of the trees are 5 to 6 years old at most. Growth is not rapid because of the dry climate and the wind, but it is regular and the trees are, on the whole, in fairly good condition. The timber which can reasonably be expected from them in about 10 or 15 years will make an appreciable contribution towards China's huge timber requirements.

FIGURE 10. – *Map to indicate the annual rainfall in China.*

Beside the poplar and eucalypt, the Chinese also use for this kind of planting robinia, sophora, elm (*Ulmus pumila*) and even willow (*Salix matsudana*) with its weeping variety *Salix pendula*. These four species, together with poplars, are planted on a large scale in all towns in north China. On the whole, the road border plantings undertaken by the municipal authorities in big towns are highly successful. The avenues planted in the city of Peking especially are impeccable.

The Chinese railways are also systematically planting rows of trees on the 50-meter-wide strips on either side of the track over which the railway company has ownership rights. Depending on soil or climate the railway company is planting eucalypts, poplars, robinia, elms, and many other kinds of broadleaved or coniferous species in rows in uniform strips 5 to 15 meters wide.

These plantations along railways, however, cannot add up in total to any large area: two 10-meter strips on either side of the track actually correspond to only 2 hectares of plantation per kilometer of line, i. e., for 20,000 to 32,000 kilometers of railway the maximum afforestation potential would be 64,000 hectares.

There are, however, more important objections. These tree-belts obstruct the view if they are continuous. They constitute a fire hazard in arid regions where coal-burning locomotives are used. They interfere with neighboring crops by casting shade or through root competition and deprive the co-operatives of land well placed and often of excellent quality. Hence it might perhaps be better for the railway company to abandon tree-planting and allow the co-operatives to use the land alongside the tracks. In places, of course, the plantations are justified in that they protect the line against wind and snow, but this is not generally the case. One may perhaps say that while plantations of this kind should not be wholly excluded, it seems excessive to make them a general practice.

Planting for protective purposes

Examining a rainfall map of China, one sees that the critical zone for erosion lies between the isohyets of 100 and 500 millimeters. The enormous tracts of land in north and northwest China where annual rainfall is below 100 millimeters are, of course, also subject to erosion, but this is mostly desert country where large-scale intervention could not be feasible.

But the 100- to 500-millimeter zone, including the upper basin and loop of the Yellow river and most of the vast steppes of Mongolia and Manchuria, afford enormous opportunities for protective plantations, differ-

FIGURE 11. – *The interior of a research laboratory for the study of loess erosion.*

ing in character according to whether they are to counter wind erosion on the plains or rain erosion on the uplands.

In the case of wind erosion, protection can be achieved by forestry operations alone without engineering works, involving fixation of sand-dunes and planting of shelterbelts. Sand-dune fixation is effected by techniques similar to those practiced in many countries of the old and the new world and do not call for any special comment.

Shelterbelts. With shelterbelts the scale of afforestation operations changes and the problem lies with thousands of square kilometers of steppes and enormous desolate flat areas scoured by pitiless winds. Here the Chinese are working on a grandiose project on the Russian model, plans for the "transformation of Nature" and for an "unbroken green belt" over the border lands on the northeast and north: Manchuria, Chahar, Jehol, Hopeh, Ordos, Shensi, Kansu, etc.

The task which China has set herself is to effect changes of climate or, more precisely, to foster microclimates favorable to the improvement or introduction of crops. The task is formidable, this afforestation of poor land, in an arid climate, in conditions little favorable to forest growth. Only the future will reveal if the scheme is overambitious.

The object is to break the violence of the winds by interposing tree-belts sufficiently wide, dense and continuous; to restore basic fertility to the land and then to cultivate that land with the help of fertilizers, using dry-farming methods applied by specially taught farmers supplied with the necessary machines.

First, there is a main network of shelterbelts consisting of windbreaks stretching roughly at right angles to the direction of the prevailing winds, 50 meters wide and spaced ten kilometers one from another. These are cut obliquely by 30-meter-wide bands, also spaced out at 10-kilometer intervals, so making a series of diamond-shaped patterns about 100 square kilometers in area. Inside this main pattern is a second network of shelterbelts, consisting of 20- to 25-meter-wide belts crossing each other so as to hedge diamond-shaped fields either of 400×600 meters (24 hectares), $400 \times \times 1{,}200$ (48 hectares) or $800 \times 1{,}200$ (96 hectares). On bare and uninhabited steppes, the pattern of screens must be closer, for the sterility of the soil itself is the result of the violence of the winds which are stronger here than elsewhere; the shelterbelts will hedge fields of 20 to 24 hectares at the most. On plains where cultivation was formerly practised and which are sparsely inhabited, and on relatively rich soils, the shelterbelts will be more widely spaced and the cultivated areas larger.

One can follow, by car or by train, the 50-meter belts for dozens and dozens of kilometers. In the Province of Kirin alone, the program, already largely completed, is for the installation in 17 districts of 21- to 50-meter bands, spaced at 10 kilometers from each other and stretching for an average east-west distance of 330 kilometers.

The network planned for this region will finally cover 340 kilometers from north to south, taking in part of the provinces of Heilungkiang in the north, Kirin in the middle and Liaoning in the south. Thus the shelterbelts will cover more than 110,000 square kilometers of steppe-land, the inland "dry sea" as the peasants call it. Of these 11 million hectares, the shelterbelts will occupy from 6 to 10 percent of the area, depending on the density of the network and the width of the screens.

Planting itself is usually preceded by many types of soil preparation. In the Taonin district, Kirin province, the first year of soil preparation, after marking out, takes the form of plowing to a depth of 30 centimeters with a multiple-share plow, followed by harrowing to break up and flatten out turves, followed by three mowings, the grass being turned in as green manure.

In the second year, the shelterbelts are planted at a density of 8,800 plants to the hectare, a spacing of 0.75×1.5 meters. Many broadleaved species are used, particularly *Ulmus pumila*, but the chief is the hardy and common poplar called *Populus simonii* or its broader-leaved variety *P. ussuriensis*.

Contrary to practice in many European countries, cuttings are not used. The poplar seed is harvested and sown in nurseries, and the plants grow in a year to a length of 60 centimeters of which 20 centimeters is root. The one-year-old plants are set out in the strips which form the shelterbelts.

The very hardy *P. simonii* seems to have become remarkably acclimatized on the steppes. It might, however, have been better to develop by hybridization one or more clones derived from this species but with, at the same time, a more valuable form, more vigorous growth and finer timber than the native species. There is room for much research into problems of this kind and Chinese foresters are not unaware of this. It has already been mentioned that such research is being pursued at the Forest Research Institute at Peking.

It is unlikely that the shelterbelt project will be a complete success. One must inevitably have hesita-

tions over the possibilities of successful afforestation under such severe conditions as those prevailing on the steppes in the Taonin and Paichantso regions, where rainfall is only 200 to 300 millimeters, the temperature range is 72° and even more, and the growing season is confined to 160 or 170 days per year.

Nevertheless, in some areas success would appear certain, for instance in the Fuyu district which lies further east and enjoys a milder climate. The look of the oldest shelterbelts here — some are 15 or 20 years old — confirm this. Elsewhere, experiments must go on and final judgment be awaited.

Protection of uplands

In checking runoff and controlling erosion on slopes, forestry operations must usually be accompanied by engineering works. This must particularly be so in the loess regions of China whose problems dwarf all others. Since 1949 the Government has expended much thought, time and money on this serious question, the responsibility for which has been entrusted to the Academy of Sciences. Under the general supervision of this learned body, plans are being elaborated for investigating the problems involved and determining the best methods of stabilizing the lands in question. This requires the collaboration of specialists in many scientific fields: geologists, geographers and pedologists, botanists, hydrologists, agronomists, foresters and economists. Survey and research teams work in the field, and the Academy analyzes their findings. The unanimous conclusion of the experts is that " it will be possible to defeat erosion only by combined water engineering and afforestation operations, side by side with improved agricultural practices ".

Agricultural measures

Steps have been taken to effect this co-ordination in practice. Upon gentle slopes and shelves, the experts are agreed upon encouraging the addition of field contouring to strip cropping, alternating " close " or thickly-sown crops like wheat with open, thinly-sown crops like maize. Alternate wheat and grass crops are also favored, the latter being given preference the steeper the overall slope.

Where the slope exceeds 6 to 8 percent it is no longer possible to cultivate loess in simple " beds ". Bench terracing must be employed, a practice that is almost as old as agriculture itself. The resulting impression is of a succession of steplike platforms, seemingly piled one above another. One may see up to 20 or 30 unbroken steps from top to bottom of a slope.

The outer bank of the benchlike field strip is built up over the years until the platform reaches the horizontal level of a terrace. The wall itself is formed not only by successive banking but also by cutting away the earth at its outer base. Successive tillages with pick and plow cause earth to move down the slope but this is not carried up again by the Chinese farmers, as the mountain cultivators have done for centuries in many European countries and still do in some parts.

When a whole slope has been terraced into horizontal platforms, the land can not only be irrigated but even be submerged at certain times of the year for growing rice. This is usually restricted to the sides of combes or canyons. Here, too, the retaining walls are usually of earth but are occasionally of rock with a concave shape making a series of little curved dams dividing off so many arduously leveled field strips.

This terrace construction belongs to the realm of agricultural engineering.

The further south one travels, the more one finds these horizontally levelled terraces that can be irrigated.

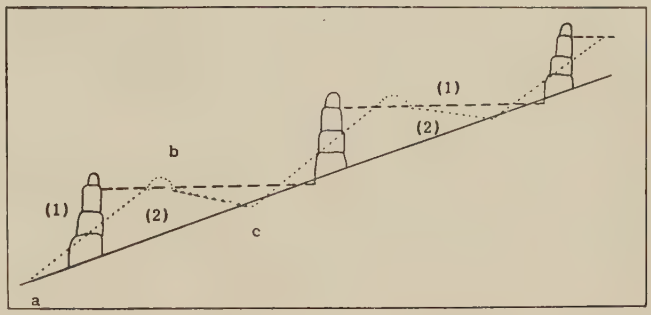


FIGURE 12. – *Diagram to demonstrate Chinese methods of terracing.*

Key

(1) *Profile* 1. a...b *Grassed or wooded slope*
(2) *Profile* 2. b...c *Cultivated platform*

This principle is the opposite of that adopted, for instance, in North Africa where the terraces are built with the outer edge of the platform somewhat higher than the inner edge so as to impound and conserve rainfall but there is a slight longitudinal slope (about 5 in 1,000) to channel off excess rainfall.

It is indeed common that the walls of terraces in China are liable to fail and even collapse under intensity of rainfall. It would appear advisable to replace steep supporting walls by sloping banks as far as the topography will permit. These banks could be stabilized with adaptable plantings of grass and treated either as natural grassland or as leys. On steep slopes where rainfall is plentiful and heavy, these intermediate sloping banks below the bench or platform could be planted with trees. This would lead to the application of a system allied to type of terracing used in Algeria, by substituting profile 2 for profile 1. The cant could be very slight, even nonexistent for irrigated crops.

In either system, the building of the down-slope bank offers no difficulty.

It would be fairly simple to establish a system of terraces of the type developed in Algeria on slopes so far cultivated without vertical walls, or at least with very low ones. In the case of high terraces one above another, the amount of earth to be shifted would be greater. The resultant reduction in the cultivable platform area would be partly compensated by the slopes planted with trees or put under grass. The old

Chinese terracing system can doubtless be maintained with constant care, but the risks could be reduced by laying aside, at intervals on the hillsides where the existing terraces were to be retained, continuous contour strips covered with trees or grass which would constitute bands strongly resistant to erosion.

Protective measures are also needed in ravines and small torrential streams to counter the undermining of their banks and beds by water and reduce the amount of solid matter carried off. For this purpose the Chinese have a whole arsenal of engineering structures to call upon: dams and cutoffs of all kinds and size, revetments, groins and other bank-protection devices, channels, culverts, drop-inlets, etc.

Structures of this kind have been already extensively built in gullies over large areas. Nevertheless, it would appear that they are not effective enough. They do cause an improvement in the water-flow but are unable to halt completely the shifting and transport of solid matter in suspension. In order to effect a readily appreciable reduction in the amount of solids carried by torrents in the loess region, larger scale works would have to be undertaken. Large earthwork dams should be erected so that most of the boulders, gravel, and silt carried by run-off water would be deposited by decantation immediately down-stream of the constructions. The height of these check dams must depend upon the cross-section and longitudinal section of the gully concerned. They should be so designed that their height can be progressively raised up to the point where the level of the basin reaches the level of the highest banks. The thickness of the structures will depend upon the volume of water and the speed of the current. It is necessary for the earth walls to have inclined receding slopes both upstream and downstream, for means to be provided for draining off the water from the sediment discharged behind the dam face and for channeling off flood waters above the reservoir space. Check dams in every ravine, every torrent and every stream flowing into the Yellow river really afford the only means of making any considerable reduction in the solid matter brought down from the hills. Later on, when afforestation begins to halt erosion in the catchment areas, it will no doubt be possible to put the sediments from the structures under crops.

The writer himself found only one structure of this type, a modest one of only 60 to 80 cubic meters, in the Tienshni mountains in Kansu province, on a torrent where the specific degradation is something like 7,000 tons per square kilometer per year, representing an exceptional content of solid matter. It is to be hoped that this method of combating erosion will become general, with the building of both large and small dams from 100 up to 10,000 cubic meters and more.

Be this as it may, the Chinese water engineers have not been inactive. 14 million hectares have been treated under the First Five-Year Plan, and results for the country as a whole are satisfactory. They do not, however, cover more than a tenth part of the overall program. Engineering projects should therefore be intensified and, above all, be concentrated on two objectives:

1. building terraces of the Algerian type on all slopes where the local-type terraces are subject to erosion;
2. wholesale construction of check dams in torrents and streams.

Forestry operations

The question was often posed whether it would be better to seek to develop grasslands or forests. Since China is short of livestock, it would seem that priority should go to stock farming: hence grassland should be preferred. But some lands, especially broken steep slopes, are extremely unpromising; their ecological conditions may be such that the only use to be gained from them is through establishing trees — as beneficial to the rural economy in general as to the fight against erosion.

This being so, afforestation should as far as possible be carried out with species that have both a reasonable economic value and sufficient ability to bind the soil. Robinia (*Pseudoacacia*) generally fulfils this twofold demand and hence is widely used. A number of co-operatives in the Tienshni region have made completely successful plantings of robinia over extensive areas, in hollows and on torrent banks and on all steep slopes. Planting has been done on horizontal terraces, continuous or discontinuous, or in hollows cut in contoured series in the loess on the slopes. The rim of the hollow is banked up so as to impound and conserve rain-water to soak slowly into the subsoil.

The work carried out on the Five Springs mountain, as it is called, near Lanchow, is worth special mention. This constitutes an experimental area, consisting of a long slope with a southern aspect, with something like 500 meters difference in elevation. Here the forest service is undertaking large-scale terracing operations combined with seeding to grass and tree-planting. Preliminary soil preparation is complete, the mountain now being scored from top to bottom with a succession of benches, terraces, diversion ditches, contour trenches, deep circular pits, etc.

Next year the biological stage of the operation will follow. This will take the form of covering the upper slopes with hardy grasses and legumes, followed by the planting, from top to bottom of the slope, of various forest species: pines and elms at higher altitudes; robinias, willows, cypresses and thujas at medium altitudes; and on the lower slopes poplars (*Populus alba*, *P. davidiana* and *P. nigra* var. *pyramidalis*), *Tamarix juniperia*, *Sophora japanica*, and *Ailanthus altissima*.

The more friable soil will then be bound by shrubs like *Eleagnus angustifolia*, *Lespedoza bicolor*, *Syringa oblata*, *Coroyana microphylla*.

The many locations visited by the writer and his colleagues clearly demonstrated the difficulties attending much of this afforestation work which is mostly undertaken on dry uplands subject to strong winds.

The chance visitor cannot judge what the results will be of work which is still in its early stages. There will certainly be failures but experience will enable techniques to be improved, and reasonable limits to be placed on undertakings. With perseverance, the success deserved will be achieved.

Training and Research

Forestry progress in China, whether concerned with the development of natural forests, with the protection of land against erosion or with afforestation, has to surmount many difficulties. Finance presents no problem nor does manpower. The chief obstacle at the moment is a shortage of engineers and technicians, i.e., of managerial and executive staff able to plan and carry out operations efficiently. The shortage is only relative, however, and is strongly felt at present because the program is so vast. The number and quality of trained specialists is increasing yearly.

Training

There are at present three specialist forestry schools: the forestry institutes of Harbin, Peking and Nanking which each cater for from 1,000 to 1,500 students, and which will eventually each be able to accommodate 4,000 to 5,000 students. The number of college students undergoing forestry training is increasing rapidly. According to official statistics, university-level forestry students increased in numbers around six-fold from 1949/50 to 1955/56, from 600 to 4,000. At the opening of the 1957/58 college year, the number of students was expected to exceed 8,000. Ultimately the number should become 12,000 or 15,000. Moreover, the 11 agricultural institutes in the big cities have their own forestry departments, each accommodating 400 to 500 students, making a total of 4,000 to 5,000 students. These numbers could well be doubled or even trebled in a short time.

In short, in a few years' time — assuming that there are facilities for enrolment — there should be at least 20,000 students reading forestry sciences in the whole of China. Starting from this year, the course will take five years. Women students are enrolled and make up about 20 percent of the student body. Owing to shortage of staff, the examinations are not very severe at present and the percentage of graduations each year is 97 to 98 percent.

While training for the higher echelons of the future thus seems assured, this is apparently not so as regards the technical and professional training of subordinate staff by the secondary schools under provincial administration. Young people having the basic educational qualifications for enrolment are few and selection is more difficult.

In a technical forestry school like that at Tailin in Manchuria, the object of training is to provide the subordinate staff to plan and supervise the carrying out of such forestry tasks as felling, extraction and transport of timber, and sawmilling, etc. The length of courses varies according to the educational standards of the trainees: on an average it is six to 18 months.

Since the start of the First Five-Year Plan, 14,000 students have obtained the engineer's diploma of the advanced forestry training course or the technical and professional training certificate. All are employed in the central forest service, the Ministry of Forests, the Ministry of Forest Industries, or in the provincial forest services.

The writer heard many complaints about the standard of qualifications of both professional foresters and subordinates. But an adequate and efficient corps of trained personnel is not to be created in a day in a country where, less than a decade ago, there was only a skeleton forestry administration with absolutely no powers of action. Nor can traditions be built up overnight. The training staffs themselves are not as yet completely equal to their jobs, and perhaps professors have yet to learn to teach.

Despite all this, however, one cannot fail to admire the effort which China is putting into the professional and technical training of specialists.

Research

The highest authority in the matter of forest research, under the control of the Chinese Academy of Sciences, is the Institute of Forest and Soil Research at Shenyang. There are two other bodies of similar eminence: the Peking Scientific Bureau for Forest Research and the Canton Scientific Bureau for Forest Research applied to tropical forests. At the provincial level there are 25 scientific and technical research stations.

Figure 13. – *Earth dikes as protection against floods. The embankments are planted with willow cuttings to hold them firm.*

FIGURE 14. – *General view of erosion in the loess in the great loop of the Yellow river.*

In the first three research institutes there are several hundred instructors, research workers and assistants studying the various scientific branches of forestry, including forest products research. Soil research is especially advanced. In the provincial stations, research is directed towards practical ends and to problems of local concern.

In regard to erosion control, the building of structures lies within the competence of the Water Engineering Service. In this connection, there is an engineering research institute at Peking and 14 provincial stations for water engineering research. These stations contribute with the forest experiment stations to research on soil conservation.

In the Province of Kansu, the Tienshui Research Station or Experimental Center for Soil Conservation has a large research area on the slopes of the Wei-Ho valley, where 200 engineers and workers are assigned.

It may be mildly surprising to note the number and diversity of all these research stations, as well as the size of the research staffs. There seens to be a certain disproportion between the number of active foresters directing operations in the field and the number of research workers giving their time to scientific and laboratory studies. This generosity in the matter of research services appears, however, to be a contemporary trend which can be observed in very many countries.

Political and Administrative Organization

In communist countries the executive and administrative organs of government are usually prolific, specialized, and bureaucratic. Corresponding, for instance, to the single Ministry of Agriculture in France, with its dependent Department of Waters and Forests, China has seven Ministries: for agriculture, state farms and land reclamation, food, food industries, river and sea fisheries, forests, and forest industries. Furthermore, numerous matters relating to soil conservation come within the province of the Ministry for Water Conservation.

Beyond that, there are several commissions which make high-level policy decisions on matters concerning more than one Ministry. Such are the Planning Commission, the Technology Commission and the Commission for the National Economy.

In forestry matters, the two vital bodies are the Ministry of Forests which is responsible for natural forests and afforestation and the Ministry of Forest Industries which is responsible for the exploitation of natural forests and the management and control of forest industries.

The Chinese Academy of Sciences presides, on the national level, over the activities of a mixed body of experts who form the National Committee for the Consolidation of Lands, a literal rendering of a title which in international nomenclature would be Soil-Conservation Committee. This committee is formed of representatives from the four interested Ministries — of forests, agriculture, farms and land reclamation, and water conservation. It operates in liaison with the provincial committees which are made up on the same principles.

This somewhat weighty organizational structure is the necessary result of many administrative services dealing with the same matter. The Committee fulfills a co-ordinating function of primary importance and should lead to the final goal of a balanced agro-silvo-pastoral economy.

The system starts off with a strong centralization. For instance, the Ministry of Forests in Peking comprises a chief minister, deputy ministers and numerous divisions and services. Direct liaison is maintained

with the 18 old provinces, the three new Manchurian provinces and the three autonomous regions of Inner Mongolia, Sinkiang and Tibet.

The forestry authority in each of these provinces is itself organized like a ministry with the same structure. This is to be expected since most of the provinces have such considerable areas of natural forest and such heavy planting programs that they are faced with tasks hardly less formidable than those of separate countries of similar land area.

At the provincial headquarters, the forest chief is helped by a secretariat and several divisions and services: divisions for personnel, forest management, afforestation and works, and research planning services.

Territorially, the unit area for forest administration usually coincides with the civil administrative unit — the district. Quite often, however, there are intermediate administrative levels (circles) between the district forest authority and the provincial headquarters.

At the district level there are separate forest management and afforestation sections, each in direct contact with the corresponding headquarters divisions on technical matters, and only administratively under the control of the district forest chief.

Where forestry operations are being very actively advanced, the afforestation sections are helped by the state forest farms. The mechanized farms, however, operate independently and have no contact with the local afforestation sections, being directly dependent upon the provincial headquarters. Similarly some important forestry projects considered as pilot-centers — Tailin for example — are outside the local organization, being also directly responsible to the provincial headquarters.

In areas where combined works for soil conservation are being carried out, co-ordination of operations at the district level is ensured by a mixed agriculture, forest and water engineering office run by a single head who is responsible to the provincial committee for soil conservation.

Each year, as new trained personnel come into service, more forest management or afforestation sections and new forest farms are established — the latter to be usually mechanized.

The organization is thus complicated but is still fluid. The services are constantly being changed. There might, it seems, be simplification by the fusion of local services, leading to better use of, and better output from, the engineers and technicians at present in service with the Ministry of Forests alone. However, while it is easy to criticize details, it is above all the results which one should look at. There is indeed no doubt about the progress achieved in a decade.

Summary

The Government of China has, then, embarked on a vast program of forestry operations. In less than four years the forestry goals of the First Five-Year Plan have been attained and exceeded.

The case is different with agriculture. Two years of disasters, one year of poor harvest, and one year only of good harvest — these have set back the hoped for increase in production. The 1957 harvests were good enough to restore a situation which, if not entirely compromised, was at least unsatisfactory. The population is not therefore threatened with famine. Grain production (including rice) has increased from an average of 140 to 190 million tons since the war ended. But public demand for all kinds of goods and commodities increases yearly: not merely for improved quality and quantity but for a greater variety of consumer goods. The Chinese authorities are therefore apparently up against greater difficulties, or at any rate have more pressing worries, in other sectors of the rural economy than in the case of forestry.

The continuance of the forestry program does not appear to face any insurmountable difficulties.

Wage increases averaging some 14 percent in industry have led to similar increases in agriculture. But it has already been seen that the problem of wages does not arise where co-operative activities are concerned — and these account for 90 percent of all the forestry operations carried out. Finance is therefore no obstacle in the execution of forestry schemes.

Population pressure is considerable. The present increase in the labor strength amounts to about 2 million men per year. This will grow every year. In 1957, the population of China already exceeded 600 million, and the rate of increase of births over deaths is 2.1 percent per year. Every year there are 12 million more Chinese babies.

Figure 15. – *The deep gullies scored in the loess by erosion.*

This situation affords another justification for embarking on further large-scale forestry operations.

Neither wage increases nor manpower present difficulties and the financing of programs in a controlled economy like that of China offers negligible difficulties. China, from being a backward state, is now fully geared for economic progress. Chinese economists estimate that during the period of the First Five-Year Plan the national revenue has increased by 50 percent. They think that the increase would have been greater but for the comparative failure of agricultural production.

The economists on the Planning Commission are therefore agreed that an appreciable increase in agriculture and forestry investments is required. These sectors have always got less substantial funds than industrial investments. In the Second Five-Year Plan now under discussion, it is proposed to increase agriculture and forestry investments from 8 percent to at least 12 percent. Final figures have not yet been fixed and it is possible that the increase will be even greater.

Agriculture investments will chiefly be in water engineering works, land clearance, and the development of uncultivated steppe and mountain lands, for the Government's main task is to prepare for the increase in the rural population which is not yet taken care of in the same degree as the development of the industrial and urban population. Great efforts will also be made to increase the yield from agricultural land by more widespread use of chemical fertilizers. The financing of this is reckoned as industrial investment.

Purely forestry investments are, of course, closely tied up with investment in agriculture. The actual figures adopted for the Second Five-Year Plan are not yet known, but it is thought that the latter plan will adhere to the provisions of the Twelve-Year Plan which included the afforestation of 92 million hectares in the 12 years.

It is claimed that 10.3 million hectares have been planted in four years. But the Twelve-Year Plan, if fully implemented, would call for an afforestation program at the rate of 10 million hectares per year, that is, four times as fast. This would be perhaps somewhat difficult to achieve.

The afforestation program has a bearing on three interrelated fields:

1. First, though least in importance, it has a bearing on tourism and urban improvement. Tree-lined avenues, parks and green spaces are needed to beautify cities and towns and attract tourists, and they are desirable in themselves in the interests of hygiene and health. None of these considerations has been overlooked.
2. Relieving the enormous timber deficit in China by the creation of productive forests is the urgent objective of the program. The timber shortage shackles the desired expansion of several industries, particularly the building industry, and hence retards general economic development. Shortages of iron, steel and other building and construction materials had been largely overcome by 1957. Only timber was in short supply. This is a serious matter, for an equilibrium in material supplies is infinitely more necessary than in funds in an economy like that of China.
3. The long-term bearing of the program is afforestation for soil conservation in the interests of the whole economy of the country. The tasks to be performed are many and widely dispersed. There is the fight against the Yellow river and its floods and the silting-up of the huge hydroelectric reservoirs (especially Sanmen), countering the floods on the Blue and the Yungting Ho rivers; the development of the steppes by the establishment of shelterbelts and other means; the improvement of water supplies. The future of agriculture and of hydroelectric output largely depends upon the successful afforestation and control of watersheds and catchment basins.

In this enormous country with all its millions of inhabitants spectacular changes are occurring everywhere. There is a prodigious development in towns and cities, in building and all pursuits. There is a considerable extension and gradual improvement of communications, roads and railways. There is a sustained industrial evolution, primarily in heavy industry but also, though less spectacularly, in light industry.

The Professor of Comparative Agriculture at the French *Institut national agronomique*, has written a most interesting book on the agricultural and social evolution of the country. He calls it *Revolution in the Chinese Countryside*. It is equally just to speak of a " forestry revolution ", for it is doubtful whether there is, anywhere, another country pursuing a policy of forest restoration so broad, ordered and planned.

Starting practically from nothing, the Chinese foresters have, in a few short years, achieved some astonishing results. The uninitiated traveller may hardly notice them; it will be 30 to 40 years before they forcibly impinge on his impressions.

The development of industry is on the way to transforming this backward agricultural country into a progressive industrial nation — to use a phrase which the Chinese employ themselves. But the industrial evolution is to be founded on the development and prosperity of the country's agriculture and forests.

(*Translated from an original French text*)

Pines for Tropical Areas

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In the tropics there is a dearth of softwoods relative to hardwoods. The properties and the versatile uses of conifers are, however, fully appreciated and increasing attention is being paid in all tropical countries to the growing of pines in planning national forestry programs. This paper summarizes information useful in the choice of species for introduction and planting.[1]

Pine forests occurring in the tropics are often held to be mere extensions of temperate zone forests into the tropical zone, and it is maintained that the only true tropical pines in the whole world are *P. merkusii* in the Asia region, and *P. hondurensis* in Mexico to Nicaragua and in the West Indies. There are none at all in Africa. Although species like *P. longifolia* in India, *P. khasya* in Burma and neighboring countries, *P. insularis* in the Philippines, *P. strobus* (var. *chiapensis*) in Central America, *P. occidentalis*, *P. tropicalis*, and *P. cubensis* of the West Indies may also be regarded as tropical, they extend their range into subtropical elevational belts of 3,000 to 6,000 feet (1,000 to 2,000 meters) or beyond.

In this paper the term "tropical pines" is taken to include all pines as they occur naturally in the tropical region, that is, including those to be found at high elevational belts where subtropical or temperate climatic conditions prevail.

Strictly, those areas lying within the tropics of Cancer and Capricorn (23½ N and S) constitute the tropical region of the world, but in order to include the 'outer tropics', as well as the transitional zone merging imperceptibly into the subtropics, 30° N and S latitudes will be taken here as the limits of the region. This corresponds approximately to the area bounded by a zone with a mean annual temperature range of 70°-75° F (21.1°-24° C) (See Figure I).

This somewhat arbitrary delineation has the advantage of including nearly the whole of Mexico, which is perhaps the richest pine-growing region in the world in terms of number of species. It also includes a major portion of South Africa where experiences with numerous exotic pines read like a success story.

Distribution of Tropical Pines

In natural distribution, it appears that the genus *Pinus* has been unable to cross the equator and the belt of tropical and equatorial forests astride it. This seems to have offered, as it were, a sufficient obstacle to the spread of pines into the southern hemisphere with the exception of a single species, namely *P. merkusii*. *P. merkusii* occurs in India, Burma, Thailand, Cambodia, Viet-Nam, the Philippine islands in the northern hemisphere and, below the equator, in Sumatra, Java, Borneo in the Indonesian islands. But in neither Australia nor New Zealand is the genus *Pinus* represented.

There are no indigenous pines in the whole continent of Africa, whether tropical or otherwise. However, there is one species *P. canariensis* in the Canary islands off the northwest coast of Africa.

Likewise, no indigenous species of pine occurs in South America, the southern limit of pines in Central America being in Nicaragua — still some 12° north of the equator.

Before proceeding to allocate species in the different countries of the region to a definite type of climate as characterized by temperature, altitude, and rainfall, some general remarks are desirable.

Thermal zones and temperature

On the basis of latitude, with average temperatures falling as one proceeds north or south of the equator, the usual rough differentiation of climatic zones is into tropical, subtropical, temperate and arctic. But owing to the uneven distribution of land and water as well as to other local factors, great variations occur within the zones as defined by latitude. It may roughly be taken that for each 1° rising latitude, there is a fall of 1° F in the mean annual temperature, while the mean annual temperature of 75° F (24° C) is generally accepted as characterizing tropical climates. Variation in temperature in the course of the year tends to increase with increasing latitude, implying a greater difference between the longest and shortest day, and also with decreasing rainfall values, while on the other hand it becomes less at high altitudes or with close proximity to the sea.

The following general differentiation of climates based on mean annual temperatures may be given:

Region	*Mean temperature*	
	F	*C*
Tropical	over 75°	over 24°
Subtropical	67° to 75°	19.5° to 24°
Warm temperate	62° to 67°	16.6° to 19.5°
Cold temperate	50° to 62°	10° to 16.6°
Arctic	less than 50°	less than 10°

[1] This paper supplements the section on tropical conifers contained in the FAO publication *Tropical Silviculture*, Volume I.

Rainfall

There are two distinctive features in the general world distribution of rainfall:

(1) the existence of two dry zones roughly along the 30° latitude north and south of the equator, which in fact is the limit of the area of the present study;

(2) general increase of precipitation outwards from these zones towards the equator and the poles.

But variations in rainfall are caused by such factors as local topography, proximity to the sea, and the influence of monsoons or trade winds, etc.

Distribution of rainfall is no less important than the total amount, and in the world three main types of rainfall may be distinguished:

(*a*) pronounced summer rainfall;

(*b*) well-distributed rainfall;

(*c*) pronounced winter rainfall.

Each gives rise to a distinct type of vegetation. Within the 30° N and 30° S limits, however, there are two distinct patterns of rainfall distribution which are important in this connection:

(*i*) seasonal rainfall — i. e., with a distinct rainy season;

(*ii*) rainfall evenly distributed throughout the year — sometines with one or two slightly pronounced peak seasons.

In contrast to the other thermal belts as differentiated by increase in latitude, in the tropics it is not so important whether the rainfall occurs in the summer or winter, there being no pronounced season of winter. Most rains fall in the hottest months during summer when the sun is highest, while the so-called winter is relatively a dry season.

In conformity with the broad classification employed in the FAO publication *Tropical Silviculture*, it will also be convenient here to distinguish three rainfall intensity classes, namely:

1. areas with over 75 inches (1,900 millimeters), as in wet forests;
2. areas with 40-75 inches (1,000-1,900 millimeters), as in moist forests;
3. areas with less than 40 inches (1,000 millimeters) as in dry forests inclusive of thorn forests and semiarid areas.

It must, of course, be noted that these rainfall figures for delineation will vary from one region to another, and they tend to decrease with increase in latitude, that is, distance away from the equator. In other words, in more northerly or southerly latitudes a particular type of vegetation can do with less rainfall than in localities nearer to the equator.

Altitude and temperature

The rate of decrease in average temperature with elevation is approximately taken as 1° F for every 300 feet (90 meters) of altitude everywhere in the world. But within the tropics the difference in elevation necessary for a 1° F drop of mean temperature is nearer 400 feet (120 meters) than 300 feet (90 meters) up to about 3,000 feet (900 meters), above which the fall is more rapid and approximates to the general world figure. Apart from variations due to local factors, the rate of fall also varies at different times of the year, being smaller in winter than in summer.

At higher elevations, the occurrence of frost is important, while at sufficiently high altitudes precipitation takes the form of snow which may accumulate and lie on the ground for varying periods. Both frost and snow have important influence on the vegetation. Ground frost may cause the die-back of low vegetation and seedlings. A layer of snow on the ground acts as a protective cover to the soil and ground vegetation by preventing further drops in temperature, while its gradual melting in spring is also a valuable source of moisture for the vegetation. In this respect 1 foot (304 millimeters) of snowfall is generally taken as the equivalent of 1 inch (25 millimeters) of rainfall. In areas bordering the external limits of the region being considered in this paper, frost occurs regularly in winter at heights above about 3,000 feet (900 meters), while as one proceeds towards the more equable areas near the equator frost rarely occurs below 6,000 feet (1,800 meters). Likewise, though snow may occasionally fall at elevations down to 4,000 feet (1,200 meters) near the 30° parallel limits, it does not lie for any appreciable period below about 7,000 feet (2,100 meters). Nearer the equator, snow seldom falls below 10,000 feet (3,000 meters); there is perpetual snow on the ground beyond 16,000 feet (4,800 meters).

Table 1 shows an empirical division of the elevational belts, based on mean temperature ranges so as to correspond in a rough manner to the world's thermal belts as

Table 1. – Empirical Division into Elevation Belts Based on Temperature Ranges

Climatic conditions	Mean temperature	Altitude	Remarks
Tropical	Over 75°F (24°C)	Up to 3,000 feet (900 meters)	
Subtropical	67°-75°F (19.5-24°C)	3,000-6,000 feet (900-1,800 meters)	(Occasional frosts in winter)
Warm temperate	62°-67°F (16.6-19.5°C)	6,000-9,000 feet (1,800-2,700 meters)	(Light frosts in winter)
Cold temperate	50°-62°F (10°-16.6° C)	9,000-13,000 feet (2,700-4,000 meters)	(Severe frosts in winter)
Arctic	Less than 50°F	Over 13,000 feet (4,000 meters)	

FIGURE 1. – *World map indicating the limits of the region of growth of tropical pines between 30° N and S latitudes.*

differentiated by latitudes, and for the purpose of allocating species to a definite elevational belt. In this respect, as consideration of this altitude-temperature relationship is restricted to the region within the 30° N and S limits, the problem is somewhat more simple than if the other variable of latitude is introduced. This does not, of course, mean that the effect of change in latitude is not present, but the influence becomes only appreciably pronounced towards the limiting parallels of 30° N and S.

At this juncture a few words of caution should be given. In the first place, in delineating rainfall zones or thermal belts corresponding to altitudinal ranges, it is never possible to draw a sharp line of demarcation between one belt and the other or between classes. Likewise in allocating a species to a thermal belt, altitudinal range, or rainfall intensity class, it must always be borne in mind that within the given range of conditions under which a species occurs there is bound to exist an optimum, and further that it is always possible for a species to encroach on colder or warmer thermal zones, into lower and higher elevational belts, or into areas of lower or higher rainfall intensity classes.

Secondly, in respect of temperature, elevation and rainfall, these represent very broad classifications, and it is always not only possible but also desirable to subdivide further those given under each of the three factors according to local requirements.

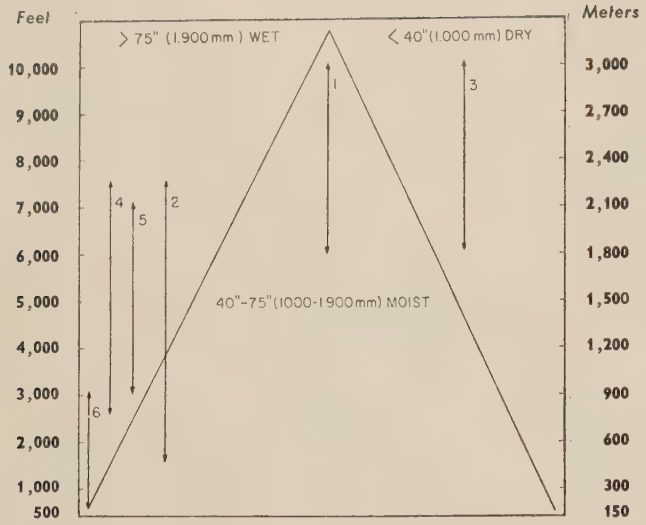
Thirdly, exact correspondence between the climates of thermal belts differentiated on the bases of latitude and altitude is by no means to be assumed. To take one example — Kikuyu, at 6,800 feet (2,073 meters) above the sea in Kenya, and Lisbon have about the same mean annual temperature of 61°F and 60°F (16.1-15.6°C) respectively, but the difference between the mean temperatures of the coolest and warmest months is only 8°F at the former compared with 22°F at the latter. In other words, there is greater uniformity throughout the year in the tropics and this factor, together with the absence of any definite resting period such as pines experience in more northerly homes, can often be the cause of failure of some species introduced in equatorial highlands. Further, in recognition of this lack of exactitude between the climates, those based on elevational belts are often described as tropical, subtropical, lower montane, higher montane, subalpine, alpine, etc.

Asia

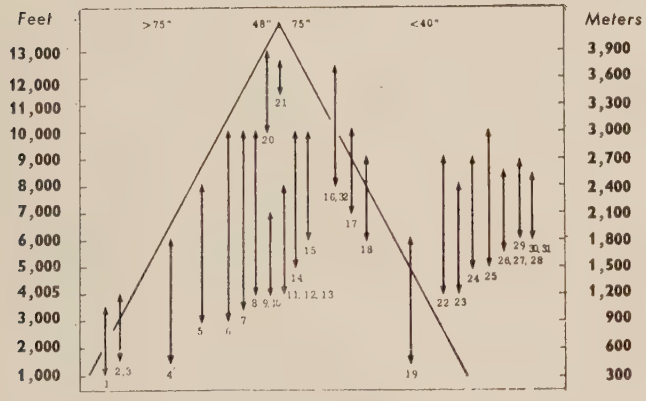
There are only six species of pines in the Indo-Malaysian region, of which three, *P. excelsa*, *P. longifolia*, and *P. gerardiana* are Himalayan. *P. khasya* occurs in Assam and Burma, *P. merkusii* in Burma, Thailand, Cambodia, Indonesia and the Philippines, while *P. insularis*, which is closely akin to *P. khasya*, is to be found only in the Philippines (see Graph 1).

1. *P. excelsa* (*wallichiana*). Confined essentially to the temperate regions of the Himalayas (6,000-10,000 feet or 2,000-3,000 meters) and stretching from Afghanistan in the west to Bhutan in the east, *P. excelsa* may descend to 4,000 feet (1,200 meters) and ascend to 12,000 feet (3,650 meters); temperature range 0°F (—17.8°C) to 100°F (37.8°C) and 40 to 50 inches (1,000 to 1,900 millimeters) of rain with snowfall in winter.

2. *P. longifolia.* Found at 1,500 to 7,500 feet (460-2,280 meters) from Afghanistan to Bhutan in India, towards the lower limit *P. longifolia* is often associated with such low-level species as *Shorea robusta*, *Bucha-*



FIGURES 2 and 3. – *Growth pattern of six pine species in tropical Asia and 32 pine species in tropical America. Numbers, relating to these species are referred to in the relevant text and also in Table 2. The triangle represents a mountain: the space on the left represents an area with over 75 inches (1,900 mm.) rainfall; on the right, under 40 inches* (1,000 *mm.), and, within the triangle, an area with 40 to 75 inches (1,000 to 1,900 mm.) rainfall.*



niana latifolia, Anogeissus latifolia, Bacchinia sp.; temperature range 25°F to 110°F (–4°C to 43.3°C); rainfall 35 to 110 inches (890 to 2,800 millimeters).

3. *P. gerardiana.* This species is found at the same altitude as *P. excelsa*, but in drier localities outside the effects of monsoons with only slight snowfall and rain of 15 to 30 inches (380 to 760 millimeters) in Afghanistan, Pakistan and the Himalayas. It furnishes edible seeds.

4. *P. khasya.* The Khasi and Naga hills in Manipur extending to hills of upper Burma at 2,500 to 7,500 feet (760 to 2,280 meters) are the natural habitat of *P. khasya*; mixed with oaks, chestnuts and other broadleaved trees; rainfall over 75 inches (1,900 millimeters) and temperatures 30° to 100°F (–1.11° to 37.8°C) with possible light frosts in winter.

5. *P. insularis* - Similar to *P. khasya*, *P. insularis* is, however, found only in the Philippines at 3,000 to 7,000 feet (900 to 2,100 meters) with rainfall as high as 140 inches (3,600 millimeters).

6. *P. merkusii* - the most tropical of all pines and the only species to cross the equator to the southern hemisphere, *P. merkusii* is found in Burma, Thailand, Cambodia, Indonesia, Philippines at 500 to 3,000 feet (150 to 900 meters) with heavy rainfall (over 75 inches or 1,900 millimeters) but on well-drained porous soil, and frequently on dry ground.

In China, within the 30° limit, there are four species as follows:

P. armandi, on mountains of China in Shensi, Yunnan, Szechwan;

P. bungeana, on limestone rocks in the central mountains of China;

P. massoniana, in southeast China following the valley of the Yangtse into Szechwan;

P. tabulaeformis, in West Yunnan and Szechwan.

Africa

P. canariensis is a native of the Canary Islands between 2,500 feet and 8,000 feet (750 to 2,400 meters), usually on dry slopes an volcanic soil. Essentially a tree of the subtropical climate with long periods of drought with a considerable winter rainfall, it furnishes one of the best timbers among pines, being both strong and durable.

America

In Mexico,[2] there are over 30 species (see Table 2) with an equally large number of varieties mostly growing at elevations between 4,000 feet and 15,000 feet (1,200 to 4,500 meters) above sea level. Five of the species (*P. hondurensis, P. oocarpa, P. montezumae, P. pseudostrobus, P. tenuifolia*) follow the mountains into Central America and as far south as Nicaragua. There are four species (*P. occidentalis, P. hondurensis, P. tropicalis, P. cubensis*) in the Caribbean — one in the Bahamas (*P. hondurensis*), one in Haiti (*P. occidentalis*), all four in Cuba, and two on the Isle of Pines (*P. tropicalis, P. hondurensis*). Pines are absent from the native flora of Puerto Rico, Jamaica, Lesser Antilles, Costa Rica, Panama, and South America.

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[2] Systematics of Central-American pines are still in need of research and clarification as well as agreement among botanists. In this paper former *P. caribaea* has been treated as being separated into *P. elliottii* of Georgia and Florida, and *P. hondurensis* of Honduras, Guatemala; the latter species is also used to denote *P. caribaea* of the West Indies islands. Likewise, *P. tropicalis, P. cubensis, P. occidentalis*, which some authors consider synonymous, are treated as separate here.

TABLE 2. -- PINE SPECIES TO BE FOUND IN TROPICAL AMERICA

Species	Height		Diameter breastheight		Elevational belt		Rainfall		Remarks
	ft.	m.	ft.	m.	ft.	m.	in.	mm.	
1. *P. hondurensis*	Up to 100	30	2.5	0.76	1,000–3,500	300–1,000	Heavy		Fairly heavy timber suitable for all general purposes; fast growing.
2. *P. tropicalis*	Up to 60	18	4	1.3	Sea level to		50–60	1,270	Fairly hard and heavy.
3. *P. cubensis*	Up to 60	18	4	1.3	3,000	900		1,520	
4. *P. strobus* var. *chiapensis*	Up to 150	46	3.5	1	2,000–6,000	600–1.800	40–75	1,000–1,900	Good timber in subtropical and tropical localities; soft, yellowish-white.
5. *P. oocarpa*	Up to 70	21	2.5	0.76	3,000–8,000	900–2,400	40–75	1,000–1,000	Wide occurrence; bad form and inferior size; is not likely to be introduced for forestry purposes.
6. *P. montezumae*	Up to 100	30	3	0.91	3,000–10,000	900–3,000	Over 40	1,000	Variable tree of wide occurrence; heavy, strong, constructional timber.
7. *P. pseudostrobus*	Up to 120	36	4.5	1.5	3,500–10,000	1,000 3,000	40–75	1,000–1,900	Quick-growing; one of the best timber-producing pines; strong, heavy, constructional timber; promising.
8. *P. michoacana*	80	24	3	0.91	4,000–10,000	1,200–3,000	40–75	1,000–1,900	Heavy, hard, good quality timber; promising.
9. *P. lawsoni*	Up to 70	21	2.5	0.76	4,000–7,000	1,200–3,000	40–75	1,000–1,900	Heavy, hard, resinous timber, but, owing to its poor form, not very important.
10. *P. pringlei*	Up to 80	24	3	0.91	4,000–7,000	1,200–2,100	Over 40	1,000	Hard, strong, heavy, constructional timber; promising and deserves trial.
11. *P. herrerai*	Up to 100	30	3	0.91	4,000–8,000	1,200–2,400	40–75	1,000–1,900	Light, yellowish – white timber of medium quality, slightly resinous; promising for subtropical localities.
12. *P. douglasiana*	Up to 100	30	3	0.91	4,000–8,000	1,200–2,400	40–75	1,000–1,000	Fairly strong, yellowish-white, suitable for construction; for promising moist-subtropical and warm temperatures.
13. *P. tenuifolia*	Up to 100	30	3	0.91	5,000–8,000	1,200–2,400	40–75	1,900–1,900	Similar, but inferior, to *P. pseudostrobus*, which should be preferred.
14. *P. patula*	Up to 100	30	3	0.91	5,000–10,000	1,500–3,000	Over 40	1,000	Medium quality timber; fast growing; one of the most important timbers in Africa.
15. *P. ayacahuite*	Up to 140	42	Over 1.5	4.5	6,000–10,000	1,800–3,000	40–75	1,000–1,900	Soft, white, easily worked timber; one of the best timber pines.
16. *P. rudis*	Middle tree	- sized			8,000–12,000	2,400–3,600	24–40	600–1,000	Slow-growing and so of no forestry importance.
17. *P. cooperi*	Up to 100	30	3	0.91	7,000–10,000	2,100–3,000	Over 40	1,000	Frost-hardy and slow-growing and drought-resistant; good for construction.
18. *P. durangensis*	Up to 120	36	Over 3	0.91	6,000–9,000	1,800–2,700	40	1,000	Light, soft, good quality constructional timber; one of the fastest-growing and most important pines.

TABLE 2. – PINE SPECIES TO BE FOUND IN TROPICAL AMERICA (*continued*)

Species	Height		Diameter breastheight		Elevational belt		Rainfall		Remarks
	ft.	m.	ft.	m.	ft.	m.	in.	mm.	
19. *P. occidentalis*	100	30	4	1.3	Sea level to 4,500	1,350	50–60	1,270–1,520	Fairly hard and heavy.
20. *P. hartwegii*	Up to 100	30	3	0.91	10,000–13,000	3,000–3,900	40–75	1,000–1,900	Can withstand snow and frost; owing to slow growth, is not likely to be of forest importance.
21. *P. flexilis*	35–50	9–15	—	—	11,500–12,500	3,450–3,750	40–75	1,000–1,900	Not of importance as exotic forest tree owing to inferior growth and size.
22. *P. leiophylla*	80–100	24–30	3	0,71	4,000–9,000	1,200–2,700	40–47	1,000–1,900	Heavy, hard, yellowish, structural timber, and also resin; promising.
23. *P. lumholtzii*	Up to 60	18	2	0,60	4,000–8,000	1,200–2,400	About 40 or less	1,000	Hard, heavy, strong timber; but not of future importance owing to bad form.
24. *P. greggii*	45	13	1.5	0.45	5,000–9,000	1,500–2,700	Less than 40	1,000	Light, weak timber.
25. *P. teocote*	Up to 100	30	2.5	0.76	5,000–10.000	1,500–3,000	40 or less	1,000	Hard, heavy, strong structural timber; although extremely drought-resistant, it does not attain good size in dry localities.
26. *P. cembroides*	20–40	6–12	0.8	0.25	5,500–8,500	1,650–2,550	15–20	380–500	One of the most drought-hardy species; suitable only for ornamental purpose or its edible nuts.
27. *P. pinceana*	20–40	6–12	—	—	5,500–8,500	1,650–2,550	15–20	380–500	One of the most drought-hardy species; suitable only for ornamental purpose or its edible nuts.
28. *P. nelsoni*	20–40	6–12	—	—	5,500–8,500	1,650–2,550	15–20	380–500	One of the most drought-hardy species; suitable only for ornamental purpose or its edible nuts.
29. *P. chihuahuana*	35–75	10.5–22.5	2.5	0.76	6,000–9,000	1,800–2,700	Under 40	1,000	Timber in not durable and is soft, brittle; not of importance
30. *P. engelmannii*	Up to 100	30	3	0.91	6,000–8,500	1,800–2,550	Under 40	1,000	Soft, white timber for general purposes; frost and drought resistant; promising.
31. *P. arizonica*	Up to 100	30	3	0.91	6,000–8,500	1,800–2,550	Under 40	1,000	Medium quality timber.
32. *P. reflexa*	50–80	15–24	—	—	—	—	40–75	1,000–1,900	On cool, moist sites of high mountains; timber easily worked.

Some Experience with Introduced Pines in the Tropics

The introduction of new species into an area is most likely to give successful and satisfactory results when carried out under either of the following two conditions:

Condition 1. from one country to another of the 'tropical region', i.e., within the 30° N and 30° S latitudes, in which case it is only necessary to grow the new species at nearly the same altitude or within the same elevational belt as in the home country;

Condition 2. from outside the 'tropical region' areas, i.e. from countries of higher latitude into localities of the 'tropical region', in which case it will be necessary to seek out areas with sufficiently high elevation to produce comparable thermal equivalent in the climate;

further provided that the new home of the species belongs to the same rainfall intensity class (whether wet, moist, or dry) as the country of origin.

Mean annual temperature, though useful, is not in itself sufficient indication of the range, which should further be narrowed down by consideration of not only the mean temperatures of the hottest and coolest months, but also the absolute maximum and minimum temperatures to be endured in the new home.

Another factor which greatly influences the successful introduction [3] of species is the existence of races or strains and the consideration of provenance. To give an example — in Malaya, lowland planting of *P. insularis* with seed from the Philippines at over 6,000 feet (1,800 meters) altitude resulted in failure. But subsequent attempts with seed obtained from trees which had spread to lower elevations of 1,500 to 2,000 feet (450 to 600 meters) as a result of shifting cultivation, proved successful. Many similar examples may be quoted from other countries.

Experiences in various countries seem to indicate that introduction under condition 1 gives far better results than that under condition 2. This is understandable as, although one passes through a similar progression of thermal belts with increase of altitude

[3] An exotic is considered fully established and naturalized in its new home when it produces fertile seeds or regenerates itself.

Table 3. – The Species Allocated to their Respective Thermal Zones

Tropical over 75°F mean (24°C)	Subtropical 67°F – 75°F (19.5°C – 24°C)	Warm temperate 62°F – 67°F (16.6°C – 19.5°C)	Cold temperate 50°F – 62°F (10°C – 16.6°C)	Arctic below 50°F (10°C)
1. *P. hondurensis*	4. *P. strobus* var. *chiapensis*	5. *P. oocarpa*	5. *P. oocarpa*	16. *P. rudis*
4. *P. strobus* var. *chaipensis*	5. *P. oocarpa*	6. *P. montezumae*	6. *P. montezumae*	20. *P. hartwegii*
	6. *P. montezumae*	7. *P. pseudostrobus*	7. *P. pseudostrobus*	
	7. *P. pseudostrobus*	8. *P. michoacana*	8. *P. michoacana*	
	8. *P. michoacana*	9. *P. lawsoni*	14. *P. patula*	
	9. *P. lawsoni*	10. *P. pringlei*	15. *P. ayacahuite*	
	10. *P. pringlei*	11. *P. herrerai*	16. *P. rudis*	
	11. *P. herrerai*	12. *P. douglasiana*	17. *P. cooperi*	
	12. *P. douglasiana*	13. *P. tenuifolia*	18. *P. duranguensis*	
	22. *P. leiophylla*	14. *P. patula*	20. *P. hartwegli*	
		15. *P. ayacahuite*	21. *P. flexilis*	
		22. *P. leiophylla*	22. *P. leiophylla*	
		23. *P. lumholtzii*	23. *P. lumholtzii*	
		25. *P. teocote*	24. *P. greggii*	
			25. *P. teocote*	
			26. *P. cembroides*	
			27. *P. pinceana*	
			28. *P. nelsoni*	
			29. *P. chihuahuana*	
			30. *P. engelmanii*	
			31. *P. arizonica*	
			32. *P. reflexa*	

FIGURE 4. – *A natural stand of* Pinus merkusii *in the mountainous regions near Dalat, Viet-Nam.*

to that encountered on proceeding from the equator toward the poles, there can never be the same degree of approximation in climates as obtained under condition 1, particularly in regard to such factors as pressure, insolation, radiation, pattern of rainfall distribution and temperature variation, differences of which are bound to influence the species in the new habitat. However, experience with 'nontropical' pines is included below.

Asia

India

P. radiata, *P. pinaster*, and *P. maritima* have been planted in small plantations in the Nilgiri Hills. Although they are promising in the earlier stages, they do not thrive well. *P. pinaster* is moderately successful at about 7,000 feet (2,100 meters) in the Himalayas. *P. sylvestris* (Scots pine), was tried at 8,000 to 9,000 feet (2,400-2,700 meters) in the Himalayas, but was not successful. Successful small-scale introductions are reported of *P. canariensis*, *P. halepensis* in Kashmir; *P. hondurensis*, *P. radiata* in Assam; *P. patula*, *P. pinaster*, *P. taeda* and *P. laricio* in the Punjab.

Ceylon

P. canariensis has been tried at 4,000 to 6,000 feet (1,200 to 1,800 meters) and is also successful on alluvial sandy loam up to 400 feet (120 meters) elevation. This species can stand a lower rainfall than any other conifer — 5 to 15 inches (127-380 millimeters) of rainfall, chiefly in winter — and is not affected by frost. It has a mean height growth of 1½ feet (46 centimeters) per annum, and is the most successful pine introduced so far.

P. excelsa has been introduced at 6,000 feet (1,800 meters) with fair results; it has a slow early growth.

P. longifolia, introduced at 6,000 feet (1,800 meters), seems promising.

Malaya

P. insularis (Benguet pine). With seed from the Philippines, these trees attain an average height of 7½ feet (2.3 meters) and maximum 13 feet (3.9 meters) in 2 years from planting — very promising. Trees in plantation at Cameron Highlands (4,800 feet or 1,440 meters) are reported to have reached 96 feet (29 meters) in height and 5 feet (1.5 meters) girth breast height in 24 years. Growth, rapid in early stages, has somewhat fallen in recent years; some saplings die from attacks of *Armillaria mellea*.

P. caribaea. From seed from British Honduras — elevation 1,800 feet (540 meters) this is found to be the fastest growing pine in the lowlands with excellent survival rate (94 percent). It has a maximum height of 22 feet (6.7 meters) in 3 years; a most promising species.

P. elliottii. A related species of *P. caribaea* from subtropical region, it is a failure in lowlands, though survival is good for several years.

P. merkusii. With seed from Sumatra, this species produces indifferent results although rapid early growth. Seeds from Java give better results and grow well in *Imperata* grass on degraded agricultural land.

P. massoniana. With seed from Hongkong, the species starts poorly and grows more slowly than others. Growth in *Imperata* grass has improved recently and trees are growing at an even rate with tendency to develop long, unbranched leaders.

Borneo

P. khasya. A failure at low altitude.

P. massoniana. A failure.

Oceania

Tropical Australia - Queensland

P. leiophylla. This species has proved hardy to extremes of heat and moisture.

P. longifolia. Plantations are very promising; seedlings are difficult to transplant after about 8 months,

and the best results are obtained with plants 1 or 2 months old transferred to tubes.

P. merkusii, *P. montezumae*. Both these species have been successfully introduced in Queensland.

P. taeda, *P. patula*, *P. elliottii*, *P. radiata*, *P. palustris*, *P. hondurensis* are established, while *P. pinaster*, *P. insularis*, *P. strobus* var. *chiapensis*, *P. tropicalis* are thriving.

Fiji

P. hondurensis, *P. elliottii*, and *P. taeda* are promising, but trials with *P. khasya*, *P. massoniana*, *P. patula*, *P. radiata* have resulted in failure.

Africa

South Africa

P. ayacahuite. This species proves hardy and fast growing in moister sites with 20 feet (6.1 meters) average height in 10 years.

P. canariensis. It has been extensively planted since 1898 en sandy and clayey loams over sandstone, granite and dolerite, chiefly on mountain slopes, the original vegetation consisting of grasses, heaths and bracken. This species is fairly hardy and resistant to snow, but frost-tender when young; its mean annual height growth is 1.5 to 3 feet (46 to 91 centimeters) and the mean annual volume production per acre is 100 to 250 cubic feet (2.8 to 7.1 cubic meters).

P. caribaea – Introduced in 1919, this species has been planted extensively on deep loamy sand near the coast; on mountain slopes and foothills on sandy and loamy soils over sandstone, granite, dolerite, quartzite. It is fairly frost-resistant, has a mean annual height growth of 3.5 feet (1 meter) and shows vigorous growth in both temperate and subtropical humid zones, withstanding well strong weed growth and swampy conditions.

P. excelsa. This species has done rather well in plantations attaining a mean height growth of 50 feet (15 meters) and a mean diameter of 10 inches (25 centimeters) in 27 years.

P. cembroides. These pines with edible seeds from Mexico grow at a temperate altitude; although growth is slow, it is hardy and promising.

P. gerardiana. Tried extensively this species has proved hardy and promising.

P. halepensis. Plantations started as early as 1893 are thriving well, grown on sandy soils containing lime near the sea coast, and elsewhere on non-acid soils formed from sandstones, shales, dolerite. The species does not thrive on sour soils or in the higher, colder parts; it is useful for limestone soils in drier areas both near the coast and in the interior, and is comparatively resistant to white ants while it is able to withstand drought and frost. Its mean height growth is 2 feet (61 centimeters) and volume production of 150 cubic feet per acre (10 cubic meters per hectare).

P. khasya. Introduced as early as 1894, there are several plantations which are very promising and likely to be of commercial importance. Its mean annual height growth is 2 to 3 feet (61 to 91 centimeters) and mean annual volume production 150 to 200 cubic feet per acre (10 to 14 cubic meters per hectare).

P. insularis. Likewise this species from the Philippines is also thriving well.

P. leiophylla. There are extensive plantations; very promising.

P. longifolia. Introduced as early as 1873, the older plantations date from 1908; it is best grown on loams and sandy loams or on grassy mountain slopes with bracken; snow-resistant, frost-hardy, and drought-resistant.

With mean height growth of 2 feet (61 centimeters) and annual production of 150 to 200 cubic feet per acre (4.2 to 5.7 cubic meters per hectare) it is considered one of the most reliable pines for the afforestation of drier sites in cool and warm temperate summer rainfall areas, but incidence of spiral grain has brought the timber into disrepute.

P. lumholtzii. Very promising.

P. maritima. Successfully introduced and raised since 1890, it is the most reliable species for general afforestation of poor sandy soils in the temperate winter and all-the-year-round rainfall zones. Generally it is not well suited to summer rainfall conditions owing to hail and is unsuited to subtropical conditions because of fungus diseases.

P. merkusii. Thriving in hot, humid areas.

P. montezumae. One of the fast-growing species in South Africa, it has proved hardy to drought and frost.

P. elliottii. This species is now established; it is noted for its freedom from serious diseases and pests and its exceptional adaptability to climate and soil conditions.

P. patula. Most widely planted, this species prefers cool mountain areas with high rainfall and frequent mists in Africa.

P. pinaster. This established species is especially useful on poor sandy soils of mountainous slopes.

P. pseudostrobus. Although established in cool, moist sites in summer-rainfall areas, the timber is not in great demand.

P. radiata. An established pine but one susceptible to damage by hail and subsequent infection by *Diplodia pinea*.

P. taeda. Although established, it is inferior to *P. patula*, *P. elliottii*, *P. radiata*.

Kenya

Early attempts with all *Pinus* species failed owing to lack of appreciation of necessity for mycorrhyzal inoculation, but subsequent plantings after importation of ' pine-soil ' have resulted in phenomenal successes with species such as *P. canariensis*, *P. caribaea*, *P. halepensis*, *P. leiophylla*, *P. montezumae*, *P. radiata*, *P. patula*, *P. ayacahuite*, *P. oocarpa*. These species are planted at 5,000 to 9,000 feet (1,500 to 2,700 meters) with 40 to 50 inches (1,000 to 1,270 millimeters) rainfall.

Nyasaland

P. cembroides, P. taeda, P. pseudostrobus, P. canariensis, P. montezumae, P. elliottii, P. patula have been successfully established at 3,000 to 7,500 feet (900 to 2,250 meters) with 40 to 110 inches (1,000 to 2,800 millimeters) rainfall and are very promising, while *P. longifolia* has been established at 2,500 to 3,500 feet (750 to 1,050 meters) with 30 inches (760 millimeters) rainfall and is promising. Indifferent results have been obtained with *P. caribaea* and *P. leiophylla.*

Rhodesias

P. canariensis. This species grows best in Southern Rhodesia at altitudes of 5,000 feet (1,500 meters) and over with a rainfall of 35 inches (890 millimeters) or more.

P. halepensis. Thriving well at altitudes of 3,000 to 5,000 feet (900 to 1,500 meters), the species needs a rainfall of up to 35 inches (890 millimeters),

P. longifolia. In Southern Rhodesia it grows best at altitudes of 5,000 feet (1,500 meters) and over with a rainfall of 35 inches (890 millimeters) or more.

P. elliottii, P. montezumae, P. patula., P. radiata, and *P. taeda* are established at 3,500 to 6,500 feet (1,050 to 1,950 meters) with a rainfall of 40 to 100 inches (1,000 to 2,540 millimeters; *P. taeda* is unusually free from pests, while *P. radiata* is attacked by *Diplodea pinea.*

P. insularis. Although established, this species is not yet grown extensively.

Nigeria

P. longifolia. A failure.

Tanganyika

P. patula. This species is established at 4,000 to 8,000 feet (1,200 to 2,400 meters) with a rainfall of 40 to 80 inches (1,000 to 2,000 millimeters).

P. radiata. Established at 4,000 to 7,000 feet (1,200 to 2,100 meters) the species requires a rainfall of 30 to 50 inches (760 to 1,270 millimeters).

Uganda

P. patula. The species thrives at an altitude of over 4,500 feet (1,350 meters), with 40 to 75 inches (1,000, to 1,900 millimeters) rainfall;

P. radiata. A thriving species, this is grown over 4,500 feet (1,350 meters), with 40 to 50 inches (1,000 to 1,270 millimeters) rainfall.

Mauritius

P. longifolia. A highly successful species, with plantations dating from 1910 — between 800 and 1,500 feet (240 to 450 meters) in elevation — where it is grown on stiff clay and laterite. It is useful in dry localities and on stiff sterile soil where most species fail. It cannot stand a heavy rainfall and has failed at 1,800 feet (540 meters) with 125 inches (3,200 millimeters) of rainfall.

P. massoniana. Successfully introduced in 1885 in different situations above 1,000 feet (300 meters), this species does best on clay and lateritic soils with sufficient moisture. The rainfall averages 58 inches (1,470 millimeters), well distributed with high atmospheric humidity; it can stand drought. Its mean height growth is 2 feet (0.6 meters) and its mean annual volume production per acre over 100 cubic feet (7 cubic meters per hectare).

Caribbean

Trinidad

P. hondurensis. The species thrives and grows very fast with 80 to 110 inches (2,032 to 2,794 millimeters) rainfall; there are no altitudinal limits. Its growth rate is over 20 feet (6.1 meters) in 4 years.

References occur in the above notes to *Pinus radiata.* Any account of the introduction and establishment of exotic pines would not be complete without mention being made of the role played by *P. radiata* in Chile or in New Zealand, although these countries are situated outside the region with which this paper is concerned. Like *P. canariensis,* the natural occurrence of *P. radiata* is restricted to a very limited range but it likewise has been successfully introduced under a wide range of conditions.

From an unimportant position in its native home of Southern California, where people would hesitate to use it even for fuelwood, it has in New Zealand, for instance, become the major general utility timber for housing and constructional uses, and as raw material for pulp and board industries. Increasing acreages in New Zealand are being planted in admixture with other pines like *P. nigra, P. ponderosa. P. strobus* and *P. contorta.*

Practices Adopted with Introduced Pines

Nursery and planting techniques

Seed is usually sown broadcast in a seed-base, where protection against rain and sun can be controlled. Protection against ants and other insects is also necessary. After germination when the seedlings are 2 inches high, they are transferred to a prepared nursery bed previously inoculated with mycorrhiza or, if possible, mixed with soil from a natural pine forest. This is absolutely essential to the success of planting on new sites. Shade and protection against heavy rain should be available, with facilities for watering in the dry season.

Seedlings are planted out 3 inches apart in lines. Damping-off is usually prevented by a sprinkling of sand on the surface, and also by spraying with Bordeaux mixture. In the case of hardy species with short roots, the plants may be pulled out when 8 to 12 inches

Table 4. – Classification of some Tropical Pines according to Number of Needles in a Fascicle and in terms of Resin and Edible Seeds

5-needled pines	3-needled pines	2-needled pines	With variable numbers	With edible seeds	From which resin is obtained
P. montezumae	*P. patula*	*P. halepensis*	*P. tabulaeformis*	*P. gerardiana*	*P. longifolia*
P. pseudostrobus	*P. khasya*	*P. massoniana*	*P. cembroides*	*P. cembroides*	*P. merkusii*
P. armandi	*P. canariensis*	*P. merkusii*	*P. lawsoni*	*P. armandi*	*P. khasya*
P. excelsa	*P. longifolia*		*P. hartwegii*	*P. pinea*	*P. montezumae*
P. ayacahuite	*P. greggii*		*P. oocarpa*	*P. cembra*	*P. chihuahuana*
P. flexilis	*P. radiata*			*P. nelsoni*	*P. oocarpa*
P. leiophylla	*P. gerardiana*			*P. pinceana*	*P. teacote*
	P. nungeana				*P. leiophylla*
	P. lumholtzii				

high for planting out in the field as naked rooted stock. With long-rooted, difficult species, it may first be necessary to sever the long roots by pulling across a piano-wire under the nursery bed. A 3-inch (7.6 centimeter) square of earth is cut round each plant and transplanting is carried out with a ball of earth. Where the planting-out site is deficient in nutrition, dressing each balled plant with about 3 ounces (85 grams) of superphosphate gives good results.

As regards the preparation of the site, if planting can be done in conjunction with *taungya*, so much the better; but usually it has to be done on dry, shallow, porous, infertile soils or grasslands unfit for agriculture, in which case planting must be done into prepared or dug holes of sufficient size to take the roots. Spacing varies according to site and species, but 6×6 feet (1.8×1.8 meters) is a pretty general rule with a trend towards wider spacing of 8×8 feet (2.4×2.4 meters) or 9×9 feet (2.7×2.7 meters) in recent years.

Stand treatment

Weeding may be necessary for the first three years but, after establishment, a plantation can usually withstand considerable competition from weeds or rank growth of grass. For good timber production, a few green-pruning operations up to a certain height of stems are required during the life of a stand for some species. First thinning is necessary from 4 to 10 years of age, depending on original spacing, locality and species. Subsequent thinnings are generally carried out on the basis of marking select trees which are to be retained as the final crop and removing the rest in stages.

Fire protection should be carried out but if, for reasons of lack of funds or personnel, it cannot be enforced, prescribed controlled burning should at least be carried out not only to reduce fire hazard but also to control hardwood invasion where it may occur. Within the range of the occurrence of pines in the tropics, hardwood invasion is not so serious a factor to be reckoned with as in the case of pine forests of higher latitudinal belts in temperate countries, and pine regeneration springs up readily in openings and with fire protection.

In harvest-cutting operations, clear-felling followed by burning of the debris and artificial regeneration by planting is widely practiced. The seed-tree method with natural regeneration, that is, clear-felling except for leaving a few scattered trees per acre, is also feasible and has been adopted in many countries, while a uniform shelterwood system with two or three regeneration fellings carried out at a few years interval, have also proved satisfactory with most species. After harvest-cuttings, controlled burning is beneficial for the preparation of the site, which should subsequently be protected from fire and grazing for at least ten years after the new crop is established, whether by artificial or natural regeneration.

Pines are essentially strong-light-demanding species, and on this silvicultural characteristic are based most of the cultural operations.

Pests and diseases

Pines are known to be subject to numerous fungal and insect pest attacks, which are liable to make their appearance on trees damaged by lopping, hail, storm, etc., or on weak trees grown on difficult sites. Although some may cause widespread destruction, many are of little more than local importance.

Fungi. Among the fungal pests, rust fungi caused by *Peridermium* spp. (syn. *Cronartium* spp.) are in a class by themselves, attacking five-needled pines most readily. They attack the needles, branches and stems, causing galls and tumors. Their occurrence is reported from Central America, while in India *P. longifolia* and *P. excelsa* are extremely susceptible.

Trametes pini and allied species are next in the order or equally important, having been reported from all coniferous regions of the world. Trees of all sizes

are attacked and the usual signs are the rotting and disintegration of the heartwood, making the timber more or less valueless and the trees liable to be broken by wind, and the appearance of the sporophores on stems or exposed roots, at points where the wood has been exposed by some physical injury. Preventive and remedial measures may consist of prevention of lopping, cutting and other forms of injury, felling trees at or below ground level, covering the stumps with earth or burning them together with all infected debris and branches, and removal in thinnings of trees damaged by snow or other causes.

Diplodia pinea is the cause of considerable concern, notably in South Africa, where extensive damage to species like *P. radiata*, *P. patula*. P. *canariensis* and others is caused by the fungus gaining ingress after injury by hailstorms.

Among the fungi of lesser importance, which locally may kill many trees by attacking the roots or the portion of stem immediately above the roots, may be mentioned *Armillaria mellea*, *Trametes radiciperda*, *Rhizina inflata* and *Fomes annosus*.

FIGURE 5. – Pinus patula *in the Republic of Mexico.*

In general, comparatively very little is known of fungus diseases in Latin America.

Bluing or blue stain of pine wood, especially in sapwood, is caused by a fungus agency and is a common cause of complaint all over the world. The spread of the fungus is known to be facilitated by ambrosia beetles. *Merulius lacrymans*, commonly known as the dry-rot fungus, is often responsible for decay of timber in contact with the ground or where there is no free circulation of air.

Insects. *Cerambycid* wood-borers of *Acolesthes* and *Baralipta* spp. attack *P. insularis* in the Philippines; in Central America *P. hondurensis* is subject to *Ips* beetle attack, while in Guatemala, attacks of the engraver beetles *Dendroctonus adjunctus* and *D. mexicana* have destroyed extensive areas of *P. rudis* forests. Among some of the other most destructive insects may be listed *Hylobius abietis* (pine weevil) which destroys young plants; *Myclophilus piniperda* (pine bark beetle), *Rhagium* spp. (pine longicorn beetle) and the *Pissodes* spp. (banded pine weevils) which cause injury by the larvae feeding on the cambium.

Pine sawflies (*Diprion* and *Neodiprion* spp.) also cause injury by their larvae feeding on the leaves. Pine-shoot Tortrix moth and Resin-gall tortrix moth (*Evetria* spp.) are common shoot-borers which may attack both young and old trees alike, while there are several species of moths (*Bupalis*, *Sphinx* spp.) which feed on leaves. Defoliation is also caused by locusts and *Euproctis terminalis*, and control measures consist of hand-picking or aerial dusting.

Wood wasps (*Sirex* spp.) are known to attack living trees, while white scale insects (*Chionaspes* spp.) and Aphides (*Adelges* spp.) are conspicuous as white covering on stems, leaves and cones. In some countries, termites are known to damage the base of trunks.

Possible control measures consist of hand-picking, spraying, aerial dusting, preservation of insect-eating birds and correct cultural methods.

CONCLUSIONS

A few species of tropical pines stand out and at once suggest themselves as deserving attention and introduction trials by virtue of their desirable qualities, such as superior growth characteristics, timber properties, adaptability, hardiness, etc. The following are some of such most promising species:

1. *P. merkusii*, *P. hondurensis* for wet tropical localities — plains up to 3,000 feet (900 meters);
2. *P. khasya*, *P. longifolia*, *P. insularis* for wet tropical and subtropical highlands;
3. *P. strobus* var. *chiapensis* for tropical to subtropical localities with 40 to 75 inches (1,000 to 1,900 millimeters) rainfall;
4. *P. tropicalis*, *P. cubensis*, *P. occidentalis* for tropical localities;

5. *P. canariensis*, one of the best pine timbers in the world, strong, heavy durable; for dry subtropical climate resembling the Mediterranean type;

6. *P. patula*, *P. durangensis* — among the fastest growing large-sized pines of good general utility timbers for subtropical and warm temperate elevational belts with over 40 inches (1,000 millimeters) rainfall;

7. *P. ayacahuite*, *P. pseudostrobus* — among the largest and best pine timbers suitable for warm temperate to cold temperate elevational belts with 40 to 75 inches (1,000 to 1,900 millimeters) rainfall;

8. *P. montezumae* — a large tree though variable; is of wide occurrence and great adaptability from subtropical to cold temperate with over 40 inches (1,000 millimeters) rainfall.

In addition, *P. herrerai*, *P. douglasiana*, *P. leiophylla*, *P. michoacana* and *P. pringlei* are among the species which deserve trial and experimentation.

Mention has been made earlier of *P. radiata*. In conclusion, a passing reference may also be made to *P. halepensis*, *P. maritima* and *P. laricio*, of the Mediterranean region, which hold promise for subtropical areas with a Mediterranean type of climate.

References

Anon. *A Handbook of Softwoods.* Department of Scientific and Industrial Research. Forest Products Research. Her Majesty's Stationery Office, London. 1957.

———. "Exotic Forest Trees in Southern Rhodesia." Paper presented to the Seventh Commonwealth Forestry Conference, Canberra, Australia, 1957.

———. "Exotic Forest Trees in Uganda." Paper presented to the Seventh Commonwealth Forestry Conference, Canberra, Australia, 1957.

Barnard, R. C. and Beveridge, A. E. "Exotic Trees in the Federation of Malaya." Paper presented to the Seventh Commonwealth Forestry Conference, Canberra, Australia, 1957.

Becking, J. H. "Silviculture of *P. merkusii* in the Tropics." *Schweiz. z. Forestw.* 101 (5), 1950. 181-191.

Cottle, G. W. "Exotic Forest Trees in Fiji.", Paper presented to the Seventh Commonwealth Forestry Conference, Canberra, Australia, 1957.

Dabral, S. N. "Notes on Some of the Exotic Forest Species Established in India." Paper presented to the Seventh Commonwealth Forestry Conference, 1957. Forest Research Institute, Dehra Dun, India. May 1957.

Dallimore, W. and Jackson, A. B. *A Handbook of Coniferae.* Edward Arnold (Publishers) Ltd., London, 1954.

Ferguson, J. H. A. "Growth and Yield of *P. merkusii* in Indonesia." *Tectona* 43, 1953. 21-36. Also as *Communication 43* of For. Res. Inst., Bogor, 1954.

Griffith, A. L. "Planting Exotic Softwoods in an Area with an Unreliable Climate." Paper presented to the Seventh Commonwealth Forestry Conference, Canberra, Australia, 1957.

Haig, I. T., Huberman, M. A. and U Aung Din. *Tropical Silviculture.* FAO, Rome. 1958.

Holdridge, L. R. "Determination of World Plant Formation from Simple Climatic Data." *Science*, 105 (2727), 1947. 367-368.

———. *Pines and other Conifers.* Fourth World Forestry Congress, Dehra Dun, India. 1954.

Hopkins, A. G. "Borneo." *Foreign Commerce Weekly*, 19 (13), 1945 (3-7, 40-41). U.S. Bur. For. and Dom. Commerce, Washington.

Howland, P. and Griffith, A. L. "*Muguga Arboretum.*" *E.A.A.F.R.O. Forestry Technical Note No. 8.*

Hviid, A. "Reforestation of Benguet Pine." Annex No. 4, *FAO/UNTAA Report No. 382.* New York. 1955.

Lamb, A.F.A. "Exotic Forest Trees in Trinidad and Tobago." Paper presented to the Seventh Commonwealth Forestry Conference, Canberra, Australia, 1957

———. "Pine Forests of British Honduras." *Emp. For. Rev.* 29 (3), 1950. 219-226.

Lizardo, L. "Benguet Pine (*Pinus insularis*)." *Philipp. J. For.* 7 : 1-4 : 43-62. 1952.

———. "The Philippine Pine Forests." *Report of the Fourth World Forestry Congress*, Dehra Dun, India, 1954.

Loock, E.E.M. "The Pines of Mexico and British Honduras." *Bull. 35*, 244 pp. 1950. Dept. For., Union of South Africa.

Martinez, Mazimino. *Los Pinos Mexicanos.* Mexico, D. F., 1948. (Second Edition.)

Parry, M.S. *Tree Planting Practices in Tropical Africa.* FAO For. Devel. Paper No. 8. Rome, 1956. 302 pp.

——— and Willan, R.L. "Exotic Forest Trees in Tanganyika." Paper presented to the Seventh Commonwealth Forestry Conference, Canberra, Australia. 1957.

Poynton, R. J. "Notes on Exotic Forest Trees in South Africa." Paper presented to the Seventh Commonwealth Forestry Conference, Canberra, Australia, 1957.

Pudden, H.H.C. "Exotic Forest Trees in the Kenya Highlands." Paper presented to the Seventh Commonwealth Forestry Conference, Canberra, Australia, 1957.

Record, S.J. and Hess, R. W. *Timbers of the New World.* New Haven, Yale University Press, 1949. 640 pp.

Rogers, L. J. "Exotic Forest Trees in Queensland." Paper presented to the Seventh Commonwealth Forestry Conference, Canberra, Australia. 1957.

———. "Pines and other Conifers." *Report of the Fourth World Forestry Congress*, Dehra Dun, India, 1954.

Troup, R. S. *Exotic Forest Trees in the British Empire.* Clarendon Press, Oxford. 1932.

———. *Silviculture of Indian Trees.* Third volume, 1 p. 195 *Pinus khasya*: pp. 1,084-1,090; *P. merkusii*: pp. 1,093-1,095. Clarendon Press, Oxford. England. 1921.

Willan, R.G.M. and McQueen, D. R. "Exotic Forest Trees in Nyasaland." Paper presented to the Seventh Commonwealth Forestry Conference, Canberra, Australia, 1957.

Wood, G.H.S. "Exotic Forest Trees in North Borneo." Paper presented to the Seventh Commonwealth Forestry Conference, Canberra, Australia. 1957.

Commodity Report

Pulp and Paper

The 1957 world figures for combined production of pulp, paper and board, and fibreboard indicated that a sharp decline in the general postwar growth of these industries had taken place. The gain in over-all industrial activity in this field was only 1.6 percent over the previous year, as compared with 5.1 percent in 1956 and an average of 7.2 percent for the period 1947-55.

Total production of paper and board in 1957 is estimated at 61.1 million metric tons as against 59.8 millions in the previous year — an increase of 2.2 percent. Wood pulp production rose by only 0.8 percent, from 49.7 million tons in 1956 to 50.1 millions in 1957, whereas fibreboard production remained unchanged at 3.4 millions.

TABLE 1. – WORLD PULP AND PAPER PRODUCTION 1947-1957

Type	1947	1955	1956	1957	1947–1955	1955–1955	1956–1957
	.....million metric tons				*.. percent p.a. ..*		
Wood pulp	25.69	46.56	49.68	50.14	7.7	6.7	0.9
Other fibre pulp	1.61	2.32	2.28	2.40	4.7	—	4.4
Paper and board	33.79	57.55	59.75	61.13	6.9	4.0	2.3
Fibreboards	1.54	3.16	3.38	3.42	9.4	7.3	1.2
TOTAL	62.63	109.59	115.09	117.09	7.2	5.1	1.6

This development prompts the question: is this decline in the growth rate of a temporary nature only? Or does it signify a leveling-off in the consumption trends at the end of a transitory period of postwar adjustments? In the following paragraphs consumption trends in the postwar period are examined in the light of earlier forecasts.

In the period 1947-56, world production of wood pulp almost doubled, from a total of 25.7 million tons in 1946 to 49.7 millions in 1955. In the same decade, production of paper and board rose from 33.8 to 59.8 million tons and of fibreboard from 1.5 to 3.4 million. This spectacular growth is, however, to a certain extent attributable to postwar recovery. This is borne out by the fact that the prewar (1937) production levels (except for fibreboards) were almost the same as in 1947; wood pulp 24.2, paper and paperboard, 29.9, fibreboards 0.25 million tons.

The Preparatory Conference on Wood Pulp Problems, convened by FAO in Montreal in 1949, reviewed the world's prospective needs for pulp products — newsprint, other printing and writing papers, wrappings, packaging materials and textile fibres. The forecast made by the Conference for the year 1955 indicated an increase in over-all requirements over 1948 of 37 percent, but it was emphasized that this figure should be considered with great caution. Doubts were, in fact, expressed whether the projected levels, which were based on normal conditions, would be reached.

In the event, however, the increase in economic activity over this period created a much larger demand for pulp products than forecast, and annual growth in the period 1948-55 exceeded 7 percent as against the 4 percent estimated at the Conference.

The annual increases in demand and production have, however, varied considerably over the period, as will be seen from Figures 1 to 3, showing the evolution of demand and production and the yearly changes. Pulp production increased rapidly in the immediate postwar years, followed by a stagnation period in 1949 which was a result of the recession in North America in this and the previous year. The Korean war gave a large impetus to the economic activity in the years 1950-51 and, as a result, pulp and paper production

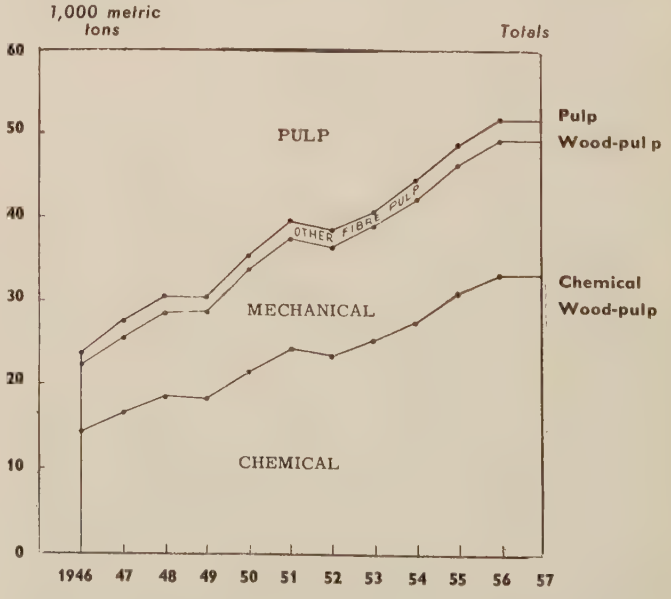


FIGURE 1. – *Development in the annual production of paper and board, fibreboard, other paper paperboard and newsprint from 1946 to 1957.*

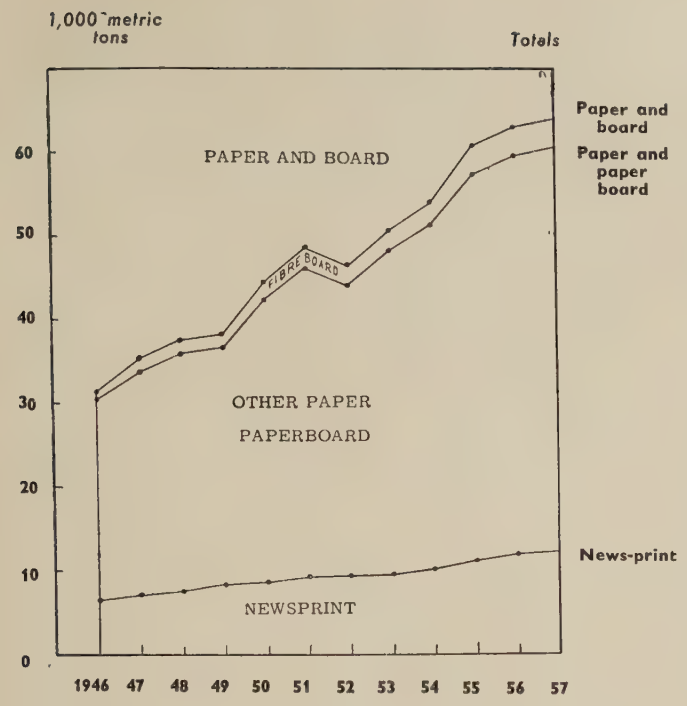


FIGURE 2. – *Development in the annual production of pulp, other fiber pulp, and chemical woodpulp, from 1946 to 1957.*

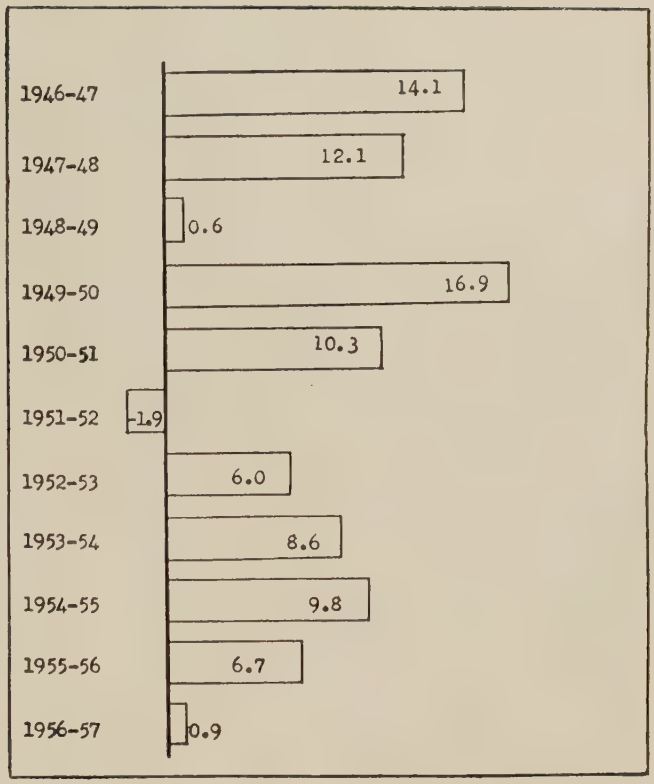


FIGURE 3. – *Annual rate of growth in world woodpulp consumption, from 1946 to 1957.*

grew rapidly in these years. Like all forest products, pulp and paper were again badly hit in 1952 by the recession which followed the 1950-51 boom. From 1953 onwards, growth in the industry began moving again with renewed confidence and expansion and modernization plans were continually being announced from all regions of the world.

By mid-1956, however, industry leaders in North America were warning of short-term difficulties for the industry which would arise from an overexpansion of production facilities. Plans then maturing were

TABLE 2. – WORLD WOOD PULP CONSUMPTION AND PRODUCTION, 1948 AND 1955

Region	1948				1955				Percentage rise 1948-55				Annual percentage increase 1948-55			
	Actual, Montreal		Actual, FAO [a]		Forecast Montreal		Actual FAO		Forecast		Actual		Forecast		Actual	
	Consumption	Production	Consumption	Production	Requirements	Production	Consumption	Production	Requirements	Production	Requirements	Production	Requirements	Production	Requirements	Production
	..... *in thousands of metric tons*															
Europe	7 000	8 050	7 550	8 155	11 800	11 100	13 040	12 975	68.6	37.9	72.7	59.1	7.8	4.7	8.1	6.8
U.S.S.R.	..	40	980	987	..	200	2 360	2 460	..	..	140.8	149.2	..	..	13.4	14.0
North America	19 255	19 010	19 030	18 740	23 705	23 915	27 365	28 025	23.1	25.8	43.8	49.5	3.0	3.3	5.3	5.9
Latin America	470	190	345	170	685	440	840	320	45.7	131.6	143.5	88.2	5.5	12.7	13.6	9.4
Africa	15	15	15	10	40	30	115	85	66.7	100.0	666.6	750.0	15.0	10.4	33.8	35.8
Asia	535	515	495	460	955	910	2 475	2 345	78.5	76.7	400.0	409.8	8.6	8.5	25.8	26.2
Oceania	200	160	190	130	450	345	415	355	125.0	115.6	118.4	173.0	12.3	11.6	11.8	15.4
GRAND TOTAL	27 475	27 980	28 605	28 652	37 635	36 940	46 610	46 565	37.0	32.0	62.9	62.5	4.6	4.0	7.2	7.2

[a] *World Forest Products Statistics - A Ten-Year Summary, 1946 - 1955*, Food and Agriculture Organization of the United Nations, Rome *1958*. In the course of the past decade, world-wide statistics have improved greatly in quality and coverage. This publication is believed to be the most authoritative world-wide statistical report on forest products for the postwar period. Therefore throughout this pulp and paper commodity report, this revised information for earlier years will be presented.

[b] Exports.

Table 3. – Postwar Growth of Pulp and Paper Production in Different Regions

Region	1947	1955	1956	1957	1947–1955	1955–1956	1956–1957
	.....*in million tons*.....				*percent increase per annum*		
North America:							
Wood pulp	17.4	28.0	29.7	29.0	6.9	6.4	—2.4
Newsprint	5.1	6.9	7.3	7.4	4.9	5.8	+1.4
Other papers & boards	18.5	26.9	27.1	26.3	4.8	0.7	—2.9
Fibreboards	1.1	1.7	1.7	1.7	6.8	—	—
All Products	42.1	63.5	65.9	64.5	5.5	3.6	—2.1
Europe:							
Wood pulp	6.9	13.0	13.6	14.2	8.2	4.7	4.4
Newsprint	1.6	3.1	3.4	3.5	8.6	9.7	1.5
Other papers & boards	6.4	13.2	13.6	14.7	9.5	3.0	8.1
Fibreboards	0.42	1.2	1.3	1.4	14.0	9.4	7.8
All Products	15.3	30.5	31.9	33.8	9.0	4.6	6.0
Rest of the World:							
Wood pulp	1.3	5.6	6.3	6.9	20.0	12.5	9.2
Newsprint	0.35	1.14	1.3	1.4	15.9	14.0	7.7
Other paper & boards	1.8	6.3	7.1	7.8	17.0	12.7	9.9
Fibreboards	0.05	0.26	0.34	0.36	24.5	31.0	5.9
All Products	3.5	13.3	15.0	16.5	18.2	13.1	9.5

expected to bring considerable new capacity into operation during 1957 and 1958. The economic recession which started in North America in 1957 brought additional pressure on the industry, and pulp, paper and board production in this region dropped by 2.3 percent from the record level of 1956 (pulp 2.4 percent, paper and boards 1.8 percent). As a result, combined operating ratios in the pulp and paper industry declined by some 10 percent from about 93 percent in 1956 to some 83 percent in the last year. Production figures for the first quarter of 1958 indicate a further slump in production, which is running some 8 percent below the corresponding period of 1957.

However, this decline in North American production did not have any large effect on production in the other regions, as demonstrated by Table 3. In fact, an increase of the growth rate for all products combined was recorded for Europe and a moderate decline in the rest of the world. Noticeable, however, is the great disparity in the 1956 and 1957 growth rates for different types of products in Europe; newsprint 9.7 and 2.0 percent, other papers and boards 3.0 and 8.1 percent, respectively.

Returning to the Montreal forecasts and historical developments as outlined in Table 2, it is noteworthy that the annual increase in production and consumption has been greater than expected in all regions save Latin America and Oceania. In Oceania, realization was close to the forecast (consumption is lower, production higher), while in Latin America consumption was greater but production lower than the estimate. In Europe, consumption was only slightly higher than expected, but production was considerably higher.

The FAO/UN survey, *World Pulp and Paper Resources and Prospects*, similarly underestimated both production and consumption. The forecasts contained in this report indicated an increase in wood pulp consumption from an average of 37.1 million tons in the period 1950-52 to 50.5 millions in the period 1960-62, an increase of 13.4 million tons which corresponds to an annual growth of 3.1 percent. In 1956 (midpoint of the survey decade) world wood pulp consumption reached 49.5 million tons, which is close to the 10-year estimate. Thus consumption actually increased at an annual rate of 6.6 percent, more than double the rate forecast. Therefore, it is not surprising to find that the rate of growth of paper and board consumption in the same period rose by 6.3 percent a year instead of the estimated rate of 3.3 percent.

In Europe, the growth has been 2.5 times that forecast, while in North America, which consumes over half of the world's total of paper and board, the annual increase was 70 percent above the forecast.

Estimates of future consumption have also been made by a number of agencies in North America, both government and private, and with the same general result as in the United Nations studies, i. e., underestimations. Similarly, forecasts by other non-United Nations authorities in Europe have also fallen far short of realizations. This, of course, implies in no way that underestimation is a general rule; it simply serves to emphasize the difficulties and limitations in making predictions for the future. These limitations arise not so much from shortcomings in methodology as from the difficulty of making intelligent guesses about economic developments in a rapidly changing world subject to national and international crises.

Nevertheless, forecasts must be made for long-range planning of the future, especially in the underdeveloped regions; they should, however, be continually revised in the light of developments. This article does not attempt to make a new set of demand estimates for the different regions of the world, but simply to draw some general conclusions from past developments and especially those of the last year.

General outlook

A glance at Tables 1 and 3 reveals two facts:

(*a*) There has been a gradual levelling-off in the post-war growth of pulp and paper production throughout the world.

(*b*) There is a large difference in the annual increase in the several regions.

Both facts may be partly explained by the postwar adjustments towards normal conditions but there is, nevertheless, no doubt that the increase will continue at a rate which is substantially higher than the population increment and also that the differences in growth between regions will continue for quite some time to come.

With all the reservations previously made as to the validity of demand forecasts, it seems reasonable to assume that world consumption of pulp and paper products will continue to grow at a minimum rate somewhere between 4 and 6 percent.[1] Given a development of the world economy more favorable than was experienced in the period between the two world wars, the annual consumption increase may well exceed the higher of these two figures.

Assuming an annual increase in the over-all demand of only 4 percent in the coming 20-year period, this means that consumption of pulp and paper products will double in approximately 18 years. Well over 90 percent of the world's paper and board production depends on wood as the primary fibrous raw material supply, and only minor changes in the supply pattern are likely to occur over this short period. Therefore, woodpulp production is likely to rise to some 100 million tons by 1975. The present pulpwood removals of about 210 million cubic meters per year will thus have to be raised to over 400 millions — an increase of close to 200 million cubic meters, of which the main part will be needed in North America and Europe.

Part of this heavy increase in wood consumption could be met from a further broadening of the raw material field by more intensive use of deciduous woods as well as more efficient utilization of industrial and forest waste. The major part of the new supply will come, however, from increased pulpwood fellings, which could only be achieved at a higher cost than today. Considerable doubts must, therefore, be expressed as to whether these regions will be able to continue to supply other regions of the world with their rapidly growing needs of products for which the raw material resources in the industrialized regions will become ever more strained, particularly in Europe. At the same time it has to be borne in mind that the deficit regions are unlikely to be able to spend increasing amounts of their foreign exchange earnings on consumer goods, such as pulp and paper.

Woodpulp

Table 5 shows the regional distribution of woodpulp production and consumption in the three years 1937, 1947 and 1956.

Turning first to the regional distribution of pulp pro-

[1] In the period 1920-37 pulp production in North America and Europe increased at an average annual rate of 4.5 and 7.6 percent, respectively.

TABLE 4. – WORLD PAPER AND BOARD CONSUMPTION, 1950-52 TO 1956 AND FAO/UN FORECAST FOR 1960-1962

Region	Paper and board consumption				Percentage increase		Annual rate of increase	
	Survey average, 1950-52	Revised average, 1950-52	Forecast average, 1960-62	Actual, 1956	Forecast, 1950-52 to 1960-62	Actual, 1950-52 to 1956	Forecast, 1950-52 to 1960-62	Actual, 1950-52 to 1956
	..... *in millions of metric tons*							
Europe	*11.82*	*11.62*	*16.38*	*16.99*	*38.6*	*46.2*	*3.3*	*8.1*
U.S.S.R.	*1.92*	*1.65*	*3.00*	*2.69*	*56.3*	*63.0*	*4.6*	*10.3*
North America	*28.57*	*28.57*	*36.83*	*35.40*	*26.9*	*23.9*	*2.6*	*4.4*
Latin America	*1.45*	*1.41*	*2.54*	*1.98*	*75.2*	*40.4*	*5.8*	*7.0*
Asia	*2.02*	*2.10*	*4.20*	*4.47*	*107.9*	*112.8*	*7.6*	*16.3*
Japan	1.13	1.12	2.50	2.48	121.2	121.4		
China	0.21	0.38	0.50	0.95	138.1	158.8		
Other countries	0.68	0.60	1.20	1.04	76.5	73.3		
Africa	*0.45*	*0.40*	*0.71*	*0.51*	*57.8*	*27.5*	*4.7*	*5.0*
Oceania	*0.67*	*0.70*	*1.00*	*0.93*	*49.2*	*32.9*	*4.1*	*5.8*
WORLD	*46.90*	*46.45*	*64.66*	*62.97*	*37.9*	*35.6*	*3.3*	*6.3*
Category								
Newsprint	9.41	9.10	12.90	12.13	37.0	33.3	3.2	5.9
Other printing and writing paper	8.75	7.94	11.29	10.78	29.0	35.8	2.6	6.3
Other paper	11.43	12.55	16.03	16.79	40.2	33.8	3.4	6.0
Board:	17.31	16.86	24.44	23.27	41.2	38.0	3.4	6.6
Paperboard		14.69		19.99		36.1		6.4
Fibreboard		2.17		3.28		51.2		8.6
TOTAL	46.90	46.45	64.66	62.97	37.9	35.6	3.3	6.3

TABLE 5. – REGIONAL PRODUCTION AND CONSUMPTION OF WOODPULP, 1937-56

Region	Production			Consumption			Balance		
	1937	1947	1956	1937	1947	1956	1937	1947	1956
	in thousands of tons								
North America	*10 900*	*17 420*	*29 815*	*12 000*	*17 910*	*29 360*	*–1 100*	*–490*	*455*
Europe: Total	*11 385*	*6 925*	*13 578*	*9 659*	*6 020*	*13 331*	*1 726*	*905*	*247*
Three northern countries	6 811	4 914	8 183	2 163	2 181	4 496	4 648	2 733	3 687
Rest of Europe	4 574	2 011	5 395	7 496	3 839	8 835	–2 922	–1 828	–3 440
U.S.S.R.	*1 034*	*745*	*2 610*	*1 034*	*687*	*2 579*	—	*58*	*31*
Asia	*900*	*330*	*2 750*	*1 380*	*350*	*2 955*	*–480*	*–20*	*–205*
Japan	900	282	2 180	1 370	288	2 322	–470	–6	–142
Mainland China	—	30	500	—	30	500	—	—	—
Rest of Asia	—	18	70	—	32	133	—	–12	–63
Latin America	*27*	*105*	*338*	*233*	*340*	*715*	*–206*	*–235*	*–377*
Africa	—	*10*	*120*	*1*	*11*	*122*	*–1*	*–1*	*–2*
Oceania	—	*155*	*469*	*52*	*200*	*509*	*–52*	*45*	*–40*
WORLD TOTAL	*24 246*	*25 690*	*49 685*	*24 360*	*25 518*	*49 521*	*–114*	*172*	*114*
World outside N. America, Europe, the U.S.S.R. and Japan	27	318	1,497	296	612	1,979	–269	–294	–482

duction, it is found that North America has increased its share of the world total from about 45 percent in 1937 to 60 percent in 1956, while Europe has decreased its part from 47 to less than 28 percent. In the other regions, production rose in the same time from 8 percent of the world total to 12 percent, mainly as a result of the combined production increases in the U.S.S.R. and Japan of more than 2.8 million tons out of the total gain of 4.3 millions in these regions.

Apart from the great progress which has been made in Japan, the U.S.S.R. and Oceania, both in the postwar period and from 1937, the most remarkable feature is the slow progress in Europe when seen in the light of its prewar achievement. This is further emphasized by a comparison with consumption which has grown much faster than production — 38 percent from 1937 to 1956 as compared with the less than 19 percent increase in production. As a result, the pulp surplus has dwindled from more than 1.7 million tons in 1937 to only some 250 thousand tons in 1956, and a further decline is recorded for the year 1957, which shows an apparent deficit of 25 thousand tons. In fact, the year 1956 is not fully representative of the trend since, as mentioned earlier, this year was characterized by a temporary stagnation in the European consumption of woodpulp. The surplus in this year thus shows an inflated figure which is supported by the fact that Europe, already in 1955, had a deficit of 65 thousand tons.

The inevitable conclusion as regards the long-term trend is therefore that, unless production facilities are expanded at a much faster rate than has been the case up till now, Europe will become a net importer of appreciable pulp quantities. In any case, this region may be discounted as a potential future supplier to deficit regions with, of course, the exception of such quantities as form part of the normal interregional trade flow and which have to be replaced by imports from North America.

Also of interest is the dominating position in Europe of three northern countries which in 1956 together produced 60 percent of the total output, or the same share as in 1937.

North America, which before the war was a net importer of more than 1 million tons, is today exporting a net quantity of more than half a million — 660, 455 and 625 thousand tons in the years 1955, 1956 and 1957, respectively. The United States, however, still has a deficit of some 1.6 million tons (1956) as against 1.9 millions in 1937. Current expansions of the production capacity in the United States should further reduce their import dependency in the next few years.

Thus, in the last analysis, Canada will become the only ultimate supplier to the importing regions. The fact that the surplus quantities required to satisfy the import needs of the deficit areas will remain marginal in relation to the large consumption in North America involves a precarious position for the importing countries as even minor changes in the internal supply/demand balance in North America may have far-reaching consequences on pulp availability in the international market.

The U.S.S.R., which has the world's largest untapped resources of coniferous woods, has increased its production 3.5 times since 1947 and more than 2.5 times over the prewar figure. Pulp production in 1956 and 1957 was 2.61 and 2.75 million tons respectively, and present

expansion plans indicate a further increase in output of about 1.2 million tons by 1960 when total production would thus reach some 3.8 millions. Of special interest is the announcement of the plans for a new rayon pulp mill with an annual capacity of 380 thousand tons. Most sources agree, however, that demand for both rayon and paper pulps will continue to outstrip domestic supply for quite a long time.

The relatively small increase in pulp output between the years 1956 and 1957 was mainly due to transport difficulties for pulpwood rather than to lack of sufficient pulping capacity. This situation is apparently expected to continue in this year since the planned production is only some 3 percent higher than in 1957.

Asia, with its more than 1,500 million inhabitants, has made remarkable progress: woodpulp production rose from 900 thousand tons before the war to more than 2.75 millions in 1956. The impact of the war is clearly demonstrated by the 1947 production figure of a mere 282 thousand tons, in the light of which postwar achievements are still more impressive.

A breakdown of the production figures shows, however, that the overwhelming part of the postwar increase was achieved by Japan and China, which together account for 97 percent of the gain of 2.43 million tons; Japan 78 and Mainland China 19 percent. The rest of the region increased their production by 52 thousand tons only, from 18 thousand to 70 thousand tons. In this connection it should be remembered, however, that these figures refer to woodpulp alone and that considerable progress has been made in this region in expanding production capacities for pulp from other raw materials than wood, in particular, bamboo. Thus, output of other fibre pulp increased from 195 thousand tons in 1947 to 470 thousands in 1956, but here again Japan and Mainland China account for a substantial part of the increase, more than 50 percent.

Pulp imports to the whole region dropped from a prewar level of 480 thousand tons to only 20 thousand in 1947 but have since then gradually increased to 205 thousand. From these figures one might at first sight assume that pulp needs are reasonably well covered by the region's own supplies. The truth is, however, that the demand is considerably higher than availability and that the countries cannot afford to spend additional foreign currency on this commodity, neither do they favor the installation of a further expansion of non-integrated paper production.

There are strong reasons to believe that the situation in Asia as regards supply of pulp and paper may deteriorate rapidly in the coming decade. Japan is already short of fibrous raw materials, the bamboo supply to the existing mills in India is in many cases critical and, although progress has been made in some of the countries, industrial expansion still falls far behind the rapidly increasing potential demand.

In Latin America with its ample potential resources the picture of the future is, of course, brighter than in Asia. Nevertheless, the difficulties in the next decades will be great, arising more from shortness of capital or rather from the relative unattractiveness of investment in an industry which may not immediately yield great profits, than from a lack of economically exploitable raw materials.

In spite of a production increase of more than 600 thousand tons in the last decade, pulp imports have climbed from 206 thousand tons in 1937 to 235 thousand tons and 377 thousand tons in the years 1947 and 1956, respectively. In addition, shortage of foreign exchange has limited the imports for which present needs are appreciably higher, notably in Argentina and Brazil. Ambitious plans have been prepared and are on their way to implementation in several countries to satisfy this unfilled demand and to meet the rising needs; in their totality, however, they still fall short of what is needed to satisfy probably future requirements.

The two remaining deficit regions of Africa and Oceania have managed to expand their production facilities of pulp in step with their consumption. Africa has raised its output by some 100 thousand tons and Oceania by some 300 thousand tons in the past decade. These figures, however, tell only part of the truth, since these regions have considerable and climbing imports of paper and boards as shown below.

Paper and board

Table 6 illustrates the regional production and consumption pattern for paper and board in the years 1937, 1947 and 1956.

The regional distribution of paper and board production and consumption is similar to that of woodpulp; North America produces and consumes about 57 percent of the world total, Europe produces 28 and consumes 26 percent and the other regions, combined, produce 15 and consume 17 percent of the total.

North America has today an exportable surplus of some 750 thousand tons, which is approximately the same as before the war, while Europe has increased its net exports from 970 thousand tons to 1.2 millions.

The deficit regions have all increased their imports, in some cases appreciably so; for instance, Asia outside of Japan and Mainland China has more than doubled its net imports from 217 thousand tons in 1947 to 540 thousand in 1956. Latin America, which achieved an expansion in output of more than 700 thousand tons between the years 1947 and 1956, still had to increase its imports by more than 110 thousand tons in the same period, practically all of the increase being newsprint.

The above analysis of the regional distribution of pulp and paper production and consumption shows that the deficit regions have increased both their production capacities and their import needs. Have they succeeded in diminishing their dependence on outside supplies? Table 7 shows regional production as a percentage of regional consumption.

Looking at the magnitude of the 1956 figures it may first be noticed how marginal are the export availabilities from North America and Europe in relation to their consumptions; for pulp, 2.7 and 1.9 percent; for paper

TABLE 6. – REGIONAL PRODUCTION AND CONSUMPTION OF PAPER AND BOARD, 1937-56

Region	Production			Consumption			Balance		
	1937	1947	1956	1937	1947	1956	1937	1947	1956
	in thousand tons								
North America	*15 832*	*23 665*	*34 445*	*15 042*	*23 050*	*33 686*	*790*	*615*	*759*
Europe:	*11 674*	*7 985*	*16 992*	*10 704*	*7 090*	*15 814*	*970*	*895*	*1 178*
Three northern countries	2 190	2 192	3 563	613	889	1 195	1 577	1 303	2 368
Rest of Europe	9 484	5 793	13 429	10 081	6 201	14 619	–597	–408	–1 190
U.S.S.R.	*965*	*789*	*2 579*	*965*	*774*	*2 625*	—	*15*	*46*
Asia	*1 080*	*595*	*3 966*		*810*	*4 393*		*–215*	*–427*
Japan	970	287	2 568		285	2 455		2	113
Mainland of China	60	160	950		160	950		—	—
Rest of Asia	50	148	448		365	98 8		–217	–540
Latin America	*270*	*545*	*1 150*	*No breakdown available*	*1 215*	*1 932*	*No breakdown available*	*–670*	*–782*
Africa	—	*25*	*135*		*225*	*380*		*–200*	*–245*
Oceania	*98*	*195*	*484*		*475*	*812*		*–280*	*–328*
WORLD TOTAL	*29 919*	*33 799*	*59 751*	*29 919*	*33 639*	*59 642*		*160*	*109*
World outside N.A., Europe and the U.S.S.R.	1 488	1 360	5 735	3 248	2 725	7 517	–1 760	–1 365	–1 782
World outside N.A., Europe, the U.S.S.R. and Japan		913	2 217		2 280	4 112		–1 367	–1 895

and board, 2.3 and 7.4 percent in North America and Europe respectively.

Of the deficit areas, Asia (excluding Japan and Mainland China) and Latin America depend on outside supply for about half of their consumption of both pulp and paper, whereas Africa and Oceania are practically self-sufficient in pulp but have to import considerable percentages of their needs of finished products; Africa 65 percent and Oceania 40 percent.

TABLE 7. – REGIONAL PRODUCTION OF PULP, PAPER AND BOARD AS A PERCENTAGE OF REGIONAL CONSUMPTION

Region	Pulp			Paper and board		
	1937	1947	1947	1937	1947	1956
	per cent					
North America	*90.8*	*97.3*	*102.7*	*105.3*	*102.7*	*102.3*
Europe	*117.9*	*115.0*	*101.9*	*109.1*	*112.1*	*107.4*
U.S.S.R.	*100.0*	*108.4*	*101.2*	*100.0*	*100.6*	*98.2*
Asia	*65.2*	*94.2*	*93.1*	?	*73.5*	*90.3*
Excl. Japan and Mainland China	—	56.3	52.6	?	40.5	45.3
Latin America	*11.6*	*30.9*	*47.3*	?	*44.9*	*59.5*
Africa	*0*	*90.9*	*98.3*	?	*11.1*	*35.5*
Oceania	*0*	*77.5*	*92.1*	?	*41.1*	*59.6*

The historical development shows that progress has been made in some of the deficit regions to lessen their dependence on outside supply. Progress in the last decade has, however, been far from satisfactory, especially in Asia (except Japan and Mainland China) and Latin America. In the first region dependence on imported pulp has actually increased while import dependency on paper and board has fallen slightly.

The danger to the deficit regions lies, however, not so much in the inadequate internal supplies as in the fact that their import needs are mainly of two key items: newsprint and coniferous pulp. More than 50 percent of the paper and all the pulp imports belong to these two essential categories.

Although considerable technological progress has been made to solve the question of newsprint manufacture from nonconiferous raw materials and to substitute coniferous pulp it will still be a long time before this may be economically achieved on a large scale, except under very particular conditions.

Since coniferous resources are scarce in the pulp and paper deficit areas — this being one of the reasons why pulp and paper industries have developed slowly — there are strong reasons to believe that imports of newsprint and coniferous pulp will continue to climb.

Conclusions

At the beginning of this report the question was posed whether the year 1957 signifies a halt in the growth trend after a transitory period of postwar adjustments. Based on the analysis which has been made of developments in the last decade it may be stated with confidence that this is not the case. Most probably the recession of last year will continue well into 1958

and will affect also the regions outside of North America. It is also likely that this period will be the most difficult encountered by the pulp and paper industries since the war. But there can be no doubt the general long-term trend will thereafter reassert itself with demand steadily growing and difficulties arising in satisfying the needs of most regions.

In fact, postwar developments indicate that, even though considerable progress has been made in the deficit areas to meet their rapidly growing needs for paper products, the outlook for the future raises graver concern than in the beginning of the decade. Thus, the reasons which induced the United Nations and its specialized agencies to draw the attention of Member Governments to the dangers inherent in the long-term trend are still valid, and determined efforts are still needed to prepare realistic development plans in the less developed regions. Naturally, developments should be based on sound economic principles since otherwise protective tariffs must be established, which ultimately means higher prices detrimental to a sound economic and cultural development. Unfortunately, developments so far have not always followed this principle, thereby creating difficulties for the realization of potential regional markets.

A. S.

LOGGING TRAINING CENTER IN INDIA

The application of modern logging techniques which reduce wastage and save time have been taught at a national Logging Training Center established in the lower Himalayas.

Organized by the Government of India with the help of the FAO technical assistance program and the Government of Switzerland, the Training Center started to function in March. Training has been imparted in two types of courses: basic logging training and use of mechanized equipment. Successive batches of trainees have been given eight weeks' training in each course.

Instruction for the first five months was given by a team of four Swiss instructors under Mr. H. G. Winkelmann, Director of the Central Forest Organization of Switzerland and Chairman of the FAO/ECE Committee on forest working techniques and training of forest workers, as a result of whose efforts equipment for the Center was brought to India from Switzerland. The cost of the equipment installed has come to the equivalent of U. S. $520,000, out of which equipment worth $16,800 was received as a gift from the Swiss Government.

Work at the Center has been continued by the officer-in-charge of the logging branch at the Indian Forest Institute and Colleges, Dehra Dun, after Mr. Winkelmann and his team of instructors left the country in July.

Precision and finish have marked various demonstrations given by the trainees to Ministers and high officials: felling, skidding, use of modern tools and operation of a skyline crane, a portable sawmill and other mechanized equipment, have been shown. Simplicity has been the outstanding character of all the tools and their method of operation.

A group of trainees watching the work of a two-man team in an especially difficult case: the leaning tree is to be felled uphill against the lean.

Courtesy: H. Winkelman

Mediterranean Forestry Subcommission

The sixth session of "Silva Mediterranea" (the Mediterranean Forestry Subcommission) was held at Madrid, 17-22 April, under the chairmanship of Professor Pavari (Italy). The 48 delegates participating represented the following members: France, Israel, Italy, Libya, Morocco, Portugal, Spain, Tunisia, Turkey, the United Kingdom and Yugoslavia. Representatives of Argentina, Chile, Iran, Sudan, and the United States also took part, and observers were present on behalf of the European Confederation of Agriculture (ECA), the Organization for European Economic Co-operation (OEEC), and the International Union of Forest Research Organizations (IUFRO). Mr. Marcel M. Leloup and Mr. E. Glesinger represented FAO; Mr. R. Fontaine was Secretary, assisted by Mr. L. Gimenez-Quintana.

A progress report on FAO's Mediterranean Development Project was given by Mr. Glesinger. The procedures being followed were approved and an *ad hoc* committee was named to collaborate with the Secretariat. The main discussion items were trends in land-use policy in the countries bordering the Mediterranean, and consequently in silvicultural practices. The delegates supported intensive silviculture as the answer to forest rehabilitation and soil conservation but insisted that advance in forestry was closely linked with improved agricultural practices, and with creating new local markets for forest produce.

Reports of the working parties on eucalypts, on corkoak, and on ecology, were endorsed. The working party on afforestation techniques recommended working out a methodology for cost/benefits analysis of afforestation in Mediterranean-type countries.

Mr. P. Martinez-Hermosilla, Director-General of Forests, Spain, was elected the new Chairman of the Subcommission, and Mr. Vieira Natividade (Portugal) and Mr. M. Badra (Tunisia) Vice-Chairmen.

Fourth FAO Conference on Wood Technology

The Fourth FAO Conference on Wood Technology was also held in Madrid, 22 April-2 May, and was attended by 59 delegates from 31 countries, including all the leading members of FAO's Technical Panel on Wood Technology. Mr. E. Glesinger represented FAO. Mr. J. Yavorsky and Mr. E. Garnum acted as Secretaries.

The main agenda items related to:

(*a*) Mechanical properties of timber
(*b*) Physical properties of timber
(*c*) Fibreboards and particle boards
(*d*) Veneer, plywood and other glued veneer constructions
(*e*) Structural grading
(*f*) Fire test methods
(*g*) Sawing and machining
(*h*) Classification of wood-base materials.

As background to the discussions, 51 technical papers had been submitted and another 40 were tabled by delegates during the Conference. Stemming from the activities of earlier Conferences, test methods for timber, plywood, fibreboards and particle boards were reviewed and new methods added to the list of recommended test procedures. The testing of the reaction to fire of building materials was the subject of prolonged discussions which resulted in agreement on the principles for conducting such tests. It was emphasized that the favorable resistance to fire of timbers as well as the considerable improvement in reaction to fire which can be achieved by treatment of wood and wood-base materials, are features which should be adequately reflected in the formulation of national and local building codes and regulations.

The Conference, which is an important instrument for an international exchange of information and the co-ordination of basic research programs, singled out for action by FAO work on problems of building materials in housing: among such problems are grading systems for wood, better utilization of the inherent strength of structural sizes of wood, and wood preservation. A group of experts was appointed to try to establish a private association of wood technologists with world-wide membership.

As Chairman, the Conference elected Mr. P. Martinez-Hermosilla of Spain. Mr. J. Campredon (France), Mr. L. J. Markwardt (U.S.A.) and Mr. B. Thunell (Sweden) were elected Vice-Chairmen.

Wood Resources and Requirements in the Far East

It is one of the characteristic anomalies of many countries which are embarking on economic development that they lean heavily on imported supplies of forest products even though they are liberally endowed

with indigenous forest resources. The early stages of industrialization call for increasing supplies of processed timber (sawnwood, sleepers, plywood, board) for residential and nonresidential construction. Increased literacy and a rising standard of living give rise to an increased and diversified demand for forest products, especially for those derived from pulp. Yet all too often current forest exploitation is export-oriented and selective, so that many usable tree species and dimensions are wasted. At the same time uncontrolled fellings for fuel are believed to be eating insidiously into the forest capital in many areas.

A study now in progress, in which FAO is collaborating closely with the Economic Commission for Asia and the Far East (ECAFE), aims at assessing the region's future timber needs, indicating what forest resources need developing (or creating) and what forest industries require expansion to meet future needs. Special attention is being paid to the part which such industries play in general economic development plans. Co-ordinators have been appointed in most countries of the region to draw up country reports that are being analyzed by the two agencies concerned. It is planned to complete the study in 1959.

Afforestation Programs

Delegates from 16 member countries took part in the seventh session of the EFC (European Forestry Commission) *Working Party on Afforestation and Reforestation* held in Great Britain from 28 May to 6 June, under the chairmanship of A. Y. Goor (Israel) and attended by the Director, Forestry Division, FAO. Canada, the European Confederation of Agriculture and the International Union of Forest Research Organizations were represented by observers.

In the course of the session participants were afforded the opportunity of visiting some of the extensive afforestation projects carried out by the Forestry Commission in England and Scotland, and of discussing in the field problems of balanced land-use and the role of forestry in this context.

The Working Party examined data on the afforestation and reforestation operations carried out in Europe in 1957, as reported by 21 member countries. The total area planted in 1957 was the largest to have so far been reported. However, in many countries implementation fell short of the annual target, owing either to the inadequacy of budgetary provisions or inability to secure from the Treasury the release of approved funds. Deforestation occurred during 1957 at about the same rate as in the past few years, in spite of the increasing abandonment of marginal agricultural land reported by several countries. Although the clearing of forest land for farming continued to be the predominant reason for the reduction of forest areas, the construction of new roads and motorways was now becoming in certain countries a fairly important factor in the loss of forest land.

Information was, for the first time, submitted at this session on detailed costs of operations per hectare. Improved reporting would be sought for the future so as to permit more valid comparison of data.

On the subject of the role of the forest in sound land-use policies, it was felt that the development of forestry in Europe now depended mainly on stepping up productivity. It was important to be able to demonstrate clearly under what conditions the extended establishment of tree plantations was a paying proposition. More reliable means of estimating costs and profits of planting operations were required, so that the profitability of individual projects could be precisely assessed. For the time being indirect benefits could not be given a quantitative monetary expression. Assessment of direct benefits would, however, have the merit of clearly indicating the relative priority of various projects within a forestry program and permit comparisons with projects of an altogether different nature. The matter would be considered again at the next session in the light of work developed in the meantime.

A fairly important exodus of rural populations, especially from mountainous regions, was reported as still occurring in many countries due mainly to the attraction of industrial centers (with their higher salaries, less strenuous types of work, and more abundant and accessible recreation facilities). To counteract this, the Working Party recommended a higher degree of mechanization of forest operations, to allow for higher salaries and more attractive jobs, and the training of a skilled labor force that can be offered full employment in forest work throughout the year. FAO was invited to undertake, in consultation with the International Labour Organisation, an inquiry into the present situation of manpower employed in forest work, the factors affecting it and the outlook for the future.

Fundamental Education in Conservation

In addition to promoting the spread of such movements as the establishment of school forests as a basis for the organizing of national tree festivals, FAO has been carrying out other activities connected with fundamental education in conservation, in conjunction with other international organizations.

Specific proposals have been made for incorporating into the curricula of elementary and secondary schools some teaching of the principles of conservation of natural resources, for submission to Unesco's International Advisory Committee on the School Curriculum. FAO has also, for instance, subsidized and contributed materially to the production by the International Union for the Conservation of Nature (IUCN) of a *Handbook on Conservation* for use primarily in elementary schools of the Near East region. This action resulted from a recommendation of FAO's Near East Forestry Commission and the material is being used as a basis for the production of a " work-kit " to be made up by a fundamental education team of Unesco who will illustrate it, translate the text into Arabic and adapt it for local use.

Equipment Section

POWERPHONE. — Two-way loudpeaker telephone for use outdoors or indoors on cranes, cableways, logging operations, at building and construction sites, etc. *Special features*: Range: 6 miles (9.6 km.) or more, with 2 to 6 stations on same line. Heard and understood up to 50 yards (46 m.). Volume decreased by pressing button.

Wyssen Skyline-Cranes, Reichenbach, Kandervalley, Switzerland.

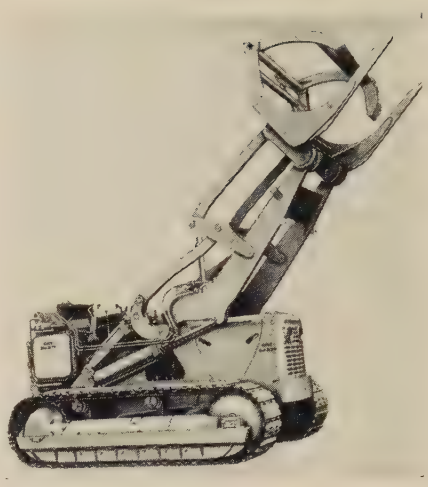
HAND RIVET SPINNER. — Manually-operated cast iron spinner complete with two threaded take-up handles and two interchangeable spinner mandrels that fit all chain pit sizes. Spun rivet gives equal pressure, equal holding strength all around rivet's shank.

Omark Industries, Inc., 9701 S. E. McLoughlin Boulevard, Portland 22, Oregon, U. S. A.

TRAXCAVATOR No. 977. — Fork for Traxcavator designed to handle 16 ft. (4.88 m.) lengths of wood up to 8,500 lb. (3,855 kg. or 1,9 cord.)

Tine spacing 75 in. (1.90 m.) center-to-center, overall width of fork 80 in. (2.03 m.). With lift arms of the No. 977 in horizontal position, forward reach ahead of bumper 110 in. (2.80 m.). *Specifications*: Engine 4 stroke diesel, 6 cylinders, 100 hp. available at flywheel at sea level. Over-all dimensions: length 17 ft. ½ in. (5.19 m.); width 8 ft. (2.44 m.); height 7 ft. 6½ in. (2.30 m.).

Caterpillar Tractor Company, Peoria, Illinois, U. S. A.

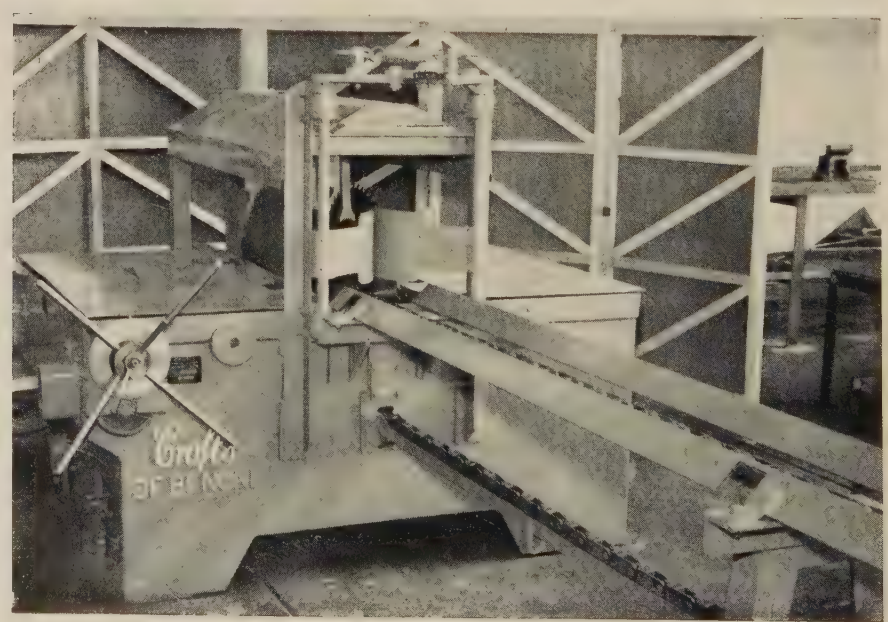


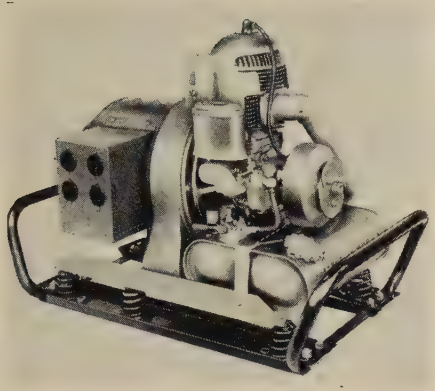
EARTH ANCHOR. — No driving or digging required. To install screw into ground with rod inclined to line of pull, attach wire rope or cable to eye. To move anchor, screw it out of ground, there is no hole to fill or damaging of the sod. It has many uses for anchoring yard light poles, gate posts, etc. Tested to withstand over 2,000 lb. (907 kg.) pull in ordinary soil conditions.

Danuser Machine Company; 500 E. 3rd Street, Fulton, Missouri, U.S.A.

ND 30 LOG EDGER. — *Main features:* automatic log centralizing device, a 3 in. (76 mm.) pitch chain enables "dogs" for pulling logs through saw blades to be put in any chain link. Precision dial indicator positions distance between blades. All power driven shafts mounted on ball and roller bearings in dustproof housings. *Specifications*: Spindle speed 1,470 r.p.m. Power required 75/100 hp. depending on duty. Distance between sawblades: max. 11 in.; min. 2¼ in. (5.7 cm.). Max. log diameter 14 in. (36 cm.). Overall height 5 ft. (1.52 m.). Floor space 4 ft. × 5 ft. × 6 in. (1.22 × 1.52 m. × 15 cm.).

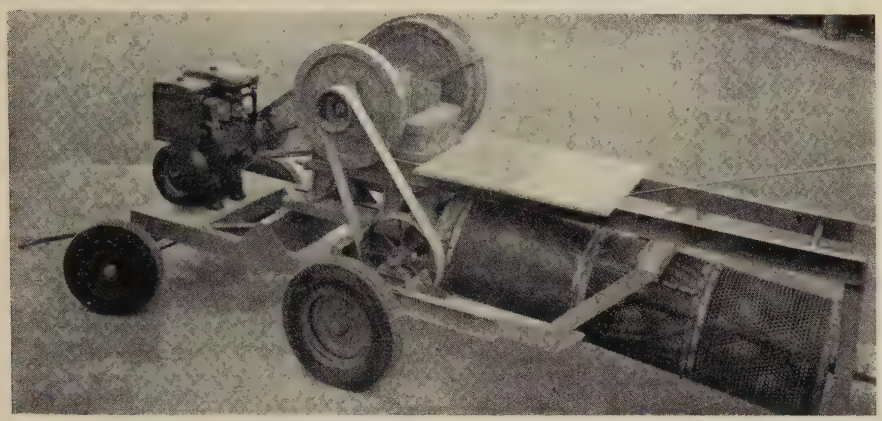
Crofts Engineers S. A. (Pty) Limited, Benoni, Transvaal, South Africa.





3,000 Watt Gasoline - Engine-Driven Generator. — Two units, the 115 Volt, 60 cycle model 8A115 and the 115/230 Volt, 60 cycle model 8A115/230 provide dependable source of power for operating electric drills, saws, concrete vibrators, floodlights and other power tools. Weight 140 lb. (63.5 kg.). Can be carried easily and used anywhere. Power provided by Homelite 2-cycle gasoline engine directly coupled to armature shaft.

Homelite, Port Chester, New York, U.S.A.



Mobile Stone Crushing and Screening Plant. — Available with either diesel or petrol driven engines. Various sizes of jaw crushers for outputs of 5 to 15 tons of crushed stone per hour; 30 in. (76 cm.) diam. grading screen gives 3 or 4 separations and oversize. Mounted on trolley fabricated from rolled steel channel and fitted as standard with pneumatic tired wheels. Ackermann type steering fitted with tow bar on front axle gives safe maneuverability on sloping ground. Safety guards are fitted over all driving belts and flywheels, loading platform placed adjacent to feed entry of crusher. Plant is of rugged construction, designed for heavy continuous use.

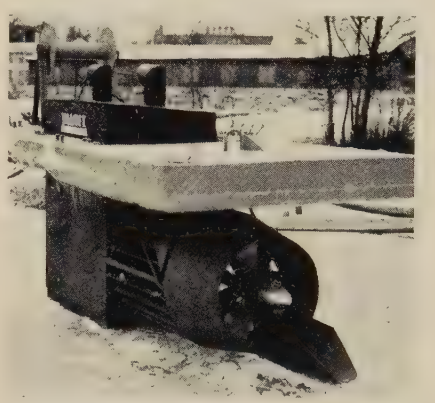
W. S. Barron and Son, Ltd., Gloucester, England.

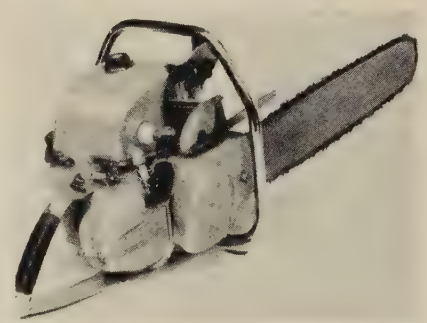
Gill Spark Arrestor. — By means of centrifugal action traps almost 100 percent of exhaust carbon. Recommended for use on tractors and trucks working in forests. Made of stainless steel. Designed so that its centrifugal action keeps arrestor scrubbed clean, *back* pressure is negligible. May be used in any position.

Erickson Products Co., 761 Clementina Street, San Francisco 3, California, U.S.A.

Flow Developer. — Produces controlled swift water flow for boosting movements and sorting work of floating timber. Adaptable to other purposes where water movement needed. Large amount of water put into motion is practical way of eliminating ice in basins and harbors. Model 11 C for instance, moves 1,000 liters (264 U. S. gall.) per sec. All steel-construction. Propeller cast bronze, balanced driven with V-belts by heavy duty electric motor (except smallest model 3 C). This model carried by hand, bigger models secured to wooden raft. Optionally delivered as unit with all steel raft and cable roll. 4 models.

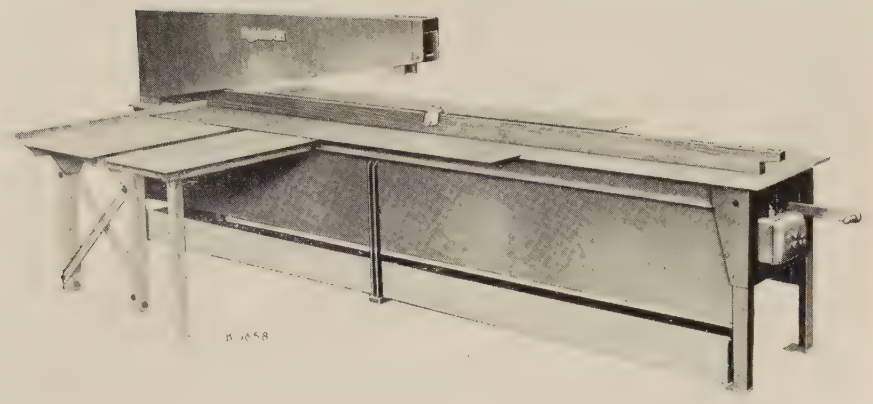
Valmet Oy., Kaivokatu 10, Helsinki, Finland.





Danarm DD8F Chain Saw. — *Specifications*: Cutting widths 18 in., 23 in. and 28 in. (46 cm., 58 cm., 71 cm.); weight 28 lb. without guide blade (12.7 kg.) diaphragm carburettor; special Villiers engine with rotary valve gives max. power at cutting speed of 5,500 r.p.m. Power output 4.5 hp. under load. Double water trap in fuel tank and adequate fuel filters at three points — all water repellent and giving full protection against ice crystals forming in fuel. Clutch-centrifugal, allowing one-hand operation. Starter — detachable automatic rewind, with pulley incorporated suitable for rope starting as alternative. Thumb controlled chain oiler.

J. Clubley Armstrong Danarm, Ltd., Wilton Road, London S.W.1, England.

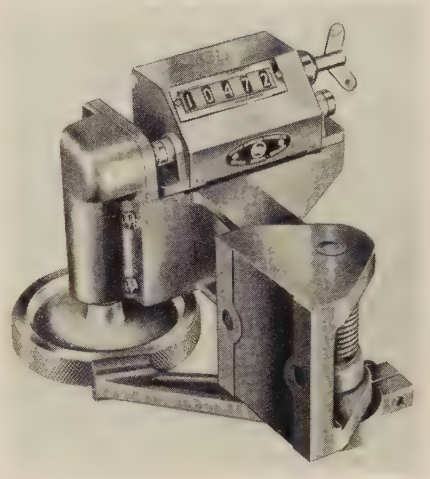


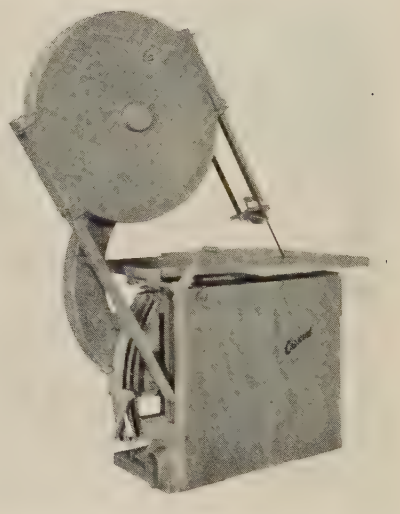
PAN-L-SAW TYPE EU/T. — New panel saw developed for sheet-cutting industries using plastic (e. g., Formica), plywood, fibreboard. Saw and cut controlled whilst holding material. Sheet held firm to table along saw-line by overhead pressure beam. Saw traverses material on cutting stroke only, completely below table on return stroke, allowing immediate off-loading. *Specifications:* Max. length of cut 10 ft. (3,048 mm.); max. thickness of cut 1 in. (25 mm.); diameter of saw 10 in. (254 mm.); B.H.P. of driving motor 1½; nett weight 1,120 lb. (508 kg.).

Thomas Robinson and Son. Ltd., Rochdale, England.

FOOTAGE COUNTERS FOR WOODWORKING MACHINERY. — A range of counters installed upon varying classes of woodworking machinery give visual record of length of timber processed. Recording unit has 5-figure capacity to 99,999 ft. all figures reset to zero instantly by 60° turn of detachable reset key. Direct measure wheel contact is principle by which recording is effected, automatic brake comes into operation immediately timber has passed. Photograph shows edger unit for attachment to straight line edgers.

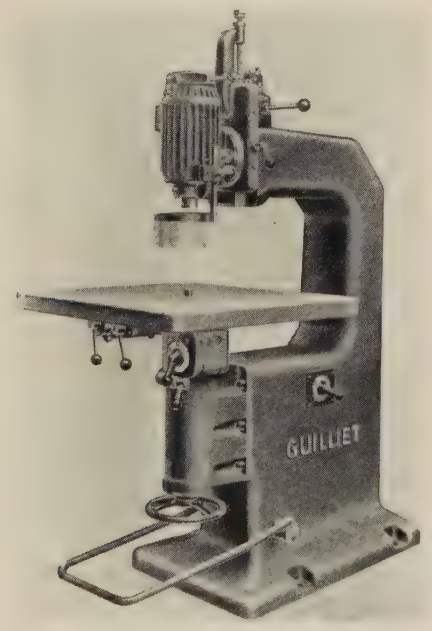
English Numbering Machines Limited, Enfield, Middlesex, England.





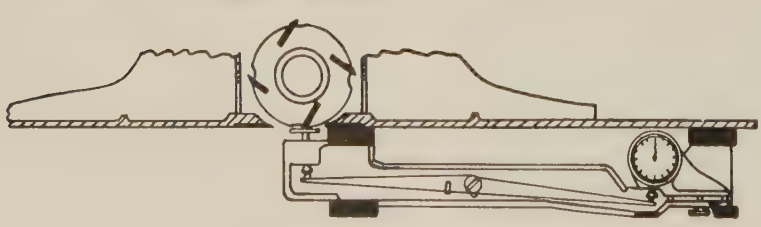
CRESCENT 36-IN. ANGLE BAND SAW — Particularly useful in working with large pieces of material. Stock 12 in. (30 cm.) square by 10 ft. (3 m.) long, can be handled by one man. Cutting angle may be gradually changed while saw is in cut. Any angle from 0 to 45 degrees to the left and 5 degrees to the right may be obtained. Graduated scale and pointer accurately indicate degree of angle. Tilt governed by crank on left hand side of table, and other parts adjust automatically to selected angle.

The Enterprise Company, Columbiana, Ohio, U.S.A.



ROUTER-MILLING MACHINE. — Using templates, machine mass-produces toys, fancy cases, cabinet-work, etc. Frequency changer converts from 50 cycles/sec. to 300 or 400 cycles/sec. to give 18,000 or 24,000 r.p.m. Cutterhead tilts sideways to horizontal up to 45°. Tilt shown on graduated scale. Cutterhead has travel distance of 130 mm. Retractable, reproducer guide operated by lever. *Specifications*: Spindle speed: 18,000 and 24,000 r.p.m. Motor power: 3 k.p. Table dimensions: 750 × 750 mm. (approx. 29½ × 29½ in.). Max. distance between table and cutterhead: 350 mm. (approx. 14 in.). Distance between arbor of cutterhead and support: 650 mm. (approx. 25½ in.) Vertical travel of spindle: 130 mm. (approx. 5 in.). Space occupied: 1,786 × 1,310 × 750 mm. (approx. 70 × 5½ × 29½ in.)

Guilliet, Auxerre, France.



PLANER CUTTER SETTER. — Used for adjusting planer cutters of smooth planers, thicknessing machines and molding machines. Dial gauge with front and back reading can be used for measuring set of saws by loosening knurled screw. Solid light-metal body. Gauge long enough to be read outside the machine. Supplied in metric and in inch divisions.

Johannes Käfer Messuhrenfabrik, Hahnstrasse 11, Schweningen a. N. (Württemberg), Germany.

News of the World

Argentina

• The Argentine Forestry Association organized last year a Symposium on Eucalyptus, the first meeting to be held in Argentina to deal especially with this genus. The conference was sponsored also by the Federal Forest Service (*Administración Nacional de Bosques*), by private industry, and by all the state forest services and related government and private organizations. Prominent experts from Italy, Brazil and Uruguay were invited to join in the discussions.

About half a million hectares of eucalypts plantations have been created in Latin America, with Brazil having the largest area. There are reported to be about 65,000 hectares in Uruguay, 50,000 in Chile, 35,000 in Argentina, and lesser areas in other countries. Plantations have been established over a wide range of climatic and ecological conditions, from the extreme of Patagonia to humid and dry tropical areas. They offer an excellent opportunity to study the behavior of eucalypts as introduced species under the most varied circumstances.

Thirty-two technical papers were submitted to the conference and the discussions centered on four topics:

1. introduction and acclimatization of Eucalyptus;
2. raising and planting out;
3. pests and diseases;
4. industrial utilization.

Follow-up action was decided on many of the recommendations of the FAO World Eucalyptus Conference (1956). The State of Buenos Aires was asked to reserve the park and arboretum of Pereyra Iraola for experimental research. Propositions were also made in regard to the insurance of forest plantations, the trade in Eucalyptus seed, the increased production of essential oils, the extension of plantations in rural areas, and the use of Eucalyptus in arid zones.

Bolivia

• In response to an inquiry about tree species to be tried out on the high Andean plateaus of Chile, Bolivia, Ecuador and Peru, a member of the United States Forest Service comments as follows:

"Paramos are treeless because the climate is unsuited for the growth of the native trees, which have small but broad evergreen leaves. Apparently the low temperature throughout the year is the limiting factor, though the freezing temperatures that may occur at any time of the year may also limit by killing tender new growth. There is no period of warm temperatures sufficiently long for the native trees to grow. However, it may be noted that scattered small trees of *Polylepis*, *Cynoxis*, and *Escallonia* do grow in protected places up to 4,000 meters (13,100 feet) elevation. In many places the paramos have been heavily used and damaged by overgrazing and fire until the vegetation has greatly deteriorated. Also, in many areas the paramos and timber lines have moved downward as much as 300 meters (1,000 feet) following cutting of trees, clearing and cultivation, fire, etc.

Obviously, trees will grow better, larger, and faster at elevations slightly below the natural timber line than in the colder paramos. Also it seems probable that large areas of the paramos will not grow trees of sawtimber size. Thus greater success would result from tree plantations at the lower elevations, which are more extensive. Also, large areas of forested mountain slopes remain to be utilized and placed under forest management.

If I were working on the problem of afforestation of the paramos, I would try four main groups of tree species. First, the native trees growing at and near the timber line, such as *Polylepis*, *Cynoxis*, and *Escallonia*, and any good timber trees of the high mountains. Many tree species will grow in plantations slightly beyond their natural ranges if given some care. As an example, small groves of Sitka spruce were planted as early as 1805 by Russians at Unalaska, near the eastern end of the treeless Aleutian Islands of Alaska and far outside the tree limits. These trees are still growing and have produced cones, but younger trees are absent, perhaps because of grazing.

Then I would try three groups of conifers. Conifers seem promising because they are the common timber line trees in North America and Eurasia. Their growth form of narrow, needle or scale, evergreen leaves apparently is efficient for growth at low temperatures slightly above freezing, while new growth of broad-leaved trees is more subject to damage by freezing weather. Also, conifers and other plants with their growth form are almost absent in the Andes and thus were not present originally to develop into successful timber line tree species along with the uplift of the mountains.

One group of conifers includes those native in the Andes. The only native conifers in the northern Andes are species of *Podocarpus*, several of which are large trees with good lumber, and a few of which almost reach the timber line. In the southern Andes, particularly Chile, are other native genera of conifers, including *Araucaria*, wich merit testing.

Next there are the timber line conifers of North America and Eurasia. Probably the highest timber lines in the western hemisphere are on the mountains of Mexico, where *Pinus hartwegii* or a related species forms forests up to about 4,300 meters (14,000 feet) elevation. I would try this and other conifers of high mountains in Mexico and Central America, including *Pinus*, *Abies religiosa* and other species, *Cupressus*, *Podocarpus*, etc. Among other conifers of high elevations and high latitudes in the United States and Canada which might be tested are *Pinus banksiana*, *Pinus contorta*, *Pseudotsuga menziesii* (*P. taxifolia*), *Abies*, *Picea*, etc. Additional species occur in Eurasia.

The third and possibly one of the most promising groups of conifers is from uniformly cool moist regions, such as along the Pacific coast from California to Alaska, where the climate in some ways approaches that of the paramos. Monterey pine and Monterey cypress are from this region. I would try among others *Picea sitchensis*, *Tsuga heterophylla*, *Thuja plicata*, *Sequoia sempervirens*, and *Chamaecyparis nootkatensis*.

Several species of *Pinus* and other conifers from warm or almost subtropical climates may prove to be successful, such as *Picea rubens* and *Abies fraseri* from the highest Southern Appalachians. These species are worthy of tests, but I believe some of the conifers in the three groups listed above are better adapted to the climate of the paramo."

Burma

• The heaviest teak stands are to be found in the monsoon regions of Burma, Thailand, Indonesia and India. Burma and Thailand have always accounted for the major volume of exported teak.

At one time substantial supplies were available from Laos, from the headwaters of the Mekong adjoining the Shan States. But these supplies have dwindled and are no longer of importance to the world market.

East Pakistan has a small production, of which only minor quantities can be spared for export to West Pakistan.

Outside the Far East and India, teak plantations have been created in various parts of Africa and in Trinidad. But these plantations are of insufficient extent to make any serious impact on world supply.

An official report on Burma's teakwood trade by an FAO officer, Mr. M. N. Gallant, deals with possible overseas markets for Burma teak. In regard to Europe, the report indicates that the teakwood market has still to reach its zenith. More teakwood is now being used in Scandinavian countries for external building members, including doors and windows, in face of the high cost of clear softwood and the extra expenditure needed for the preservation of softwood by periodic painting. Also, there has been a phenomenal development in the use of teakwood furniture in Scandinavia. Exports to the United States from Scandinavia of teakwood furniture are on the increase. The call is for black-stripe teak veneer logs, squares and flitches along with planks, boards and scantlings for base stock and furniture supports. Furniture color is so much a matter of fashion that uncertainty is expressed by buyers as to the long-term prospects of furniture manufacture in Europe based on teakwood. But there is yet no sign of a waning interest in the timber. Light yellow-brown colors have for some time past, even before the war, gradually been gaining ground over the reds in the furniture trade, while teakwood has the added advantage that it needs little more than an oil finish as compared with the more expensive polish finishes required by other woods. The heaviest importers of teakwood in continental Europe are at present Denmark, Scandinavia, West Germany and the Netherlands, in that order.

Chile

• A report, *Chile: Potential Pulp and Paper Exporter*, of the FAO/ECLA/UNTAA Pulp and Paper Advisory Group for Latin America (FAO/Economic Commission for Latin America/United Nations Technical Assistance Administration) brings up to date an earlier edition, bearing a similar title, published in 1956. The report concludes that conditions in Chile are favorable for the creation of an industry for the export of pulp and paper, which would represent for the country a revenue in foreign currency of about U.S.$70 million a year.

The plantations of *Pinus radiata* in the south central part of Chile, which constitute one of the most important raw material resources for the production of pulp and paper in Latin America, provide the potential source for this new industry. The bulk of raw material which these artificial pine forests are capable of producing in the future is large enough to support a considerably greater industrial capacity than is foreseen in Chile during the next ten years. The study only takes into consideration those plantations, which are found in the seven provinces of Maule, Linares, Nuble, Bio-Bio, Concepcion, Arauco and Malleco. Estimates made in 1956 indicate that the extent of these plantations well exceeds 200,000 hectares, and that most of them are near or have already exceeded the age corresponding to the maximum economic yield. The average annual production is estimated at a minimum of 2.8 million cubic meters per year for the period 1956/1969 — a quantity which would be sufficient for the production of some 600,000 tons of pulp or about 850,000 tons of newsprint a year.

In 1955, consumption of newsprint in Chile was slightly over 25,000 tons a year, and that of other papers and boards 42,000 tons, which corresponds to a *per caput* consumption of 3.8 and 6.2 kilograms per year respectively. Future demand for newsprint is estimated to rise to 39,000 tons and 50,000 tons respectively in 1960 and 1965, and to 61,000 and 77,000 tons respectively for other papers and boards. Expansion plans for the industry include three mills at present under construction or recently in operation — a newsprint mill with a rated capacity of about 50,000 tons, a Kraft pulp mill with an annual capacity of about 50,000 tons, a Kraft pulp mill with an annual capacity of some 70,000 tons and a small sulphate pulp mill with an estimated annual production of some 7,000 tons. In addition there is a project under serious consideration for a pulp mill with an annual capacity of some 70,000 to 90,000 tons.

The major obstacle for a large-scale development of pulp and paper is Chile's transport situation, both in regard to raw materials as well as for the shipment of finished goods.

An adequate transportation system must be developed. From the location point of view the report recommends the port of Talcahuanco, near Concepcion, as being the most suitable harbor for pulp and paper export. Plans to improve this port are under way and will probably be carried out in the next few years, thus solving the shipping problem. The situation as regards electric power, however, is far from satisfactory, demand greatly exceeding existing supply possibilities. For this reason the report advises that new mill projects should take into account the possibility of developing their own electricity supply sources.

Estimates of investment and production costs are given for 16 mill projects of different capacities. Pulp and paper projects require large capital investments. For the development program outlined in the report, which would include the annual production of some 300,000 tons of newsprint, 100,000 tons of Kraft papers, 200,000 tons of unbleached pulp and 50,000 tons of bleached pulp, some $170 million would be needed of which about $50 million would be in local currency. Chile would have to rely on foreign financing to implement a program of the recommended size in a reasonably short time.

It is clear that Chile offers great possibilities for industrial development based on its Insignis pine plantations. Conservation, and especially fire prevention and control, are essential elements in such a development.

Cyprus

• The steps which have been taken by the Cyprus Government to reduce damage to forests from unrestricted goat grazing fall into two categories:;

1. the elimination of grazing rights in the State forests;
2. the reduction of free range goat grazing on private land.

The first was achieved by the following means:

(*a*) granting compensation to graziers;

(*b*) legal undertakings by graziers and their families not to take up grazing again once they have been compensated;

(c) provision of alternative employment for graziers;

(d) in certain exceptional cases, the acceptance of sheep grazing instead of goat grazing.

Free range goat grazing has been eliminated from much private land by means of the Goat Law which was enacted in 1913. The main features of this law are:

(a) At the instance of the villagers or of a District Commissioner, a ballot may be held to decide whether or not free ranging goats should be excluded from the village land.

(b) If the ballot shows the majority of property owners to be in favor of the exclusion of free ranging goats, the Commissioner may declare such a village a prescribed village.

(c) As from 12 months after the publication of the order declaring a village to be a prescribed village, it is unlawful for any person to acquire, keep or suffer any goat to graze within the village lands; provided that each household may be allowed to keep and graze not more than five goats (excluding kids produced by these and under the age of 15 months), and that such goats and kids be kept tethered and under proper supervision.

(d) The penalty for disobeying this law is a monetary fine and confiscation of all animals kept in contravention of the law.

The problem of goat grazing has not been tackled by the Forest Department alone. The Agricultural and Forest Departments have constantly worked in co-operation and with the full support of the Government. The progress achieved would have been impossible without a considerable degree of support from the general public.

The elimination of grazing rights in the forest has tended to concentrate grazing on land outside the forest. The abandonment of agricultural fallows in favor of simple rotations incorporating leguminous crops is reducing the use of fallow land for grazing, while the conversion of unproductive land into arable is reducing the area of the former available for grazing. This has caused landowners, in their own interests, to bring pressure to bear upon graziers to reduce or dispense with their flocks of goats.

The Agricultural Department aims at the replacement of free ranging goats by tethered goats and by sheep. To this end improved varieties of goats are being imported; the growing of fodder crops is encouraged and steps are being taken to produce improved pastures by seeding. The new poultry broiler industry and other livestock developments are also increasing alternative meat supplies. The removal of free ranging goats from the forest does not therefore result in benefit to the forest at the expense of other interests. The measures taken will ultimately lead to the elimination of an uneconomic form of production and eventually benefit the whole of the rural community.

Ecuador

• On 20 January 1958 the President promulgated a forest law which forms a practical basis for the functions of the recently established Forest Department of the Ministry of Agriculture and Forests.

Although Ecuador has abundant forest resources, these are concentrated in certain parts of the country, and other areas where there is a high density of population require afforesting for protection purposes and to yield local supplies of wood. Wherever afforestation is necessary, the Government can insist upon the necessary operations being carried out by an owner, or else can carry out the work itself. Expropriation is authorized as a last resort.

The forest law allows government intervention to safeguard privately-owned forests which substantially contribute to the "conservation of the soil, watercourses, forest life or of any other natural resource or public work." The exploitation of forests declared to be "protection forests" are subject to regulations made by the Forest Department. Commercial cutting of all other forests also requires authorization from the Department.

Substantial benefits are granted to owners whose forests are declared "protective" or to those who, at the request of the Forest Department or else on their own initiative, plant up uncultivated land. These include exemption from taxes, financial help, loans, and technical assistance. The creation of co-operatives is encouraged.

The law also provides for a forestry fund, to be financed on the one hand from budget allocations and, on the other, from income from cutting licences or permits, fines, penalties, and inspection charges.

France

• Number 8 of *Rivières et Forêts*, the review devoted to conserving France's natural heritage, published by the *Société de publicité pour la France et l'étranger*, has appeared recently. It contains a preface by Georges Duhamel and the entire issue is dedicated to the nature reserves and parks of France. There are some excellent studies on the reserves of Chambord, Camargue, etc., and a large-scale enquiry among a wide cross-section of people on the need of twentieth century man for parks where the fresh air and peaceful surroundings can help him to recover his spiritual equilibrium. The issue also contains some articles on the renaissance of the village.

Greece

• Each year Greece imports forest products to the value of U.S.$31 million while at the same time, losing a considerable number of workers by emigration. If forestry development were accelerated by afforestation and reforestation with fast-growing species, the quantity of forest products at present imported could probably be raised within the country and increased possibilities for local employment would occur.

The great obstacles to forest development are uncontrolled grazing and the cutting of fuelwood by the mountain populations, a situation not restricted to Greece. A report to FAO lists the measures required to correct the position as follows:

1. Make a land-use survey and classification to establish a balance between agriculture, forestry and grazing needs.
2. Free the forest from overgrazing, by improvement of grazing lands and sound range management, including replacing the free-ranging type of herd by breeds which are more productive and profitable.
3. Increase the amount of state capital invested in forestry to a sum double that provided today, for planting with quick-growing species, beginning with the most favorable areas, and for larger-scale afforestation of catchment basins of torrents and erodible areas.
4. Finance co-operatives, either of forest owners or of poor communities, to enable them to plant quick-growing species to supply local fuelwood and other needs and to yield timber and resin for industry.

INDIA: *The development of offshore fisheries forms a major feature of the technical assistance provided to India by FAO. A boat construction expert working on the Malabar coast has reported to the Fisheries Division on the construction of a 25 ft. (7.62 m.) Pablo type fishing boat. Eight carpenters from the district were trained in the new boatbuilding methods needed for this mechanized boat, instruction being given in the local language. The building proceeded somewhat slowly because the local carpenters, although experienced builders of country craft, needed time to assimilate the methods.*

Keel, stem and stern were finally made and erected, templets lined up and planking of the hull done. Trials with heat-bending of local woods, Terminalia tomentosa *and* Artocarpus hirsuta, *were made, but these timbers were not found suitable for the bent frames and it was finally decided to use* Largerstroemia lanceolata. *This timber is known as a good oil- or steam-bending wood, cheap and in good supply at Mangalore.*

As building of the boat proceeded, it became evident that the supply of materials in Mangalore, which was sufficient for country-craft building, was not adequate for the construction of mechanized boats; the required sizes of timber, nails, screws, rivets, washers, etc., and certain tools were simply not available. Nails and rivets had to be made on the spot. Other steady sources have had to be sought to provide the new boatbuilding yard with the necessary materials.

5. Establish pulp and board factories financed by the State to use low-quality wood and material at present not utilized.

India

• A shifting cultivation control scheme was started in the First Five-Year Plan period in Assam, Andhra Pradesh, Bihar, Madhya Pradesh, Orissa and Tripura. It is contemplated to extend this scheme during the Second Five-Year Plan period at an estimated cost of 30 million rupees. It is expected that about 27,000 tribal families will be resettled and 208 demonstration centers set up.

Iran

• The FAO forestry team in Iran has been concentrating on developing a demonstration forest area at Lowe in northern Iran. Mr. H. A. M. Gläser, who is in charge of the project, has sent photographs of a forest access road, the earth work for which has been completed. The dam and pits for the foundation of a bridge have been made and a great part of the 100 cubic meters of stone needed for the piles of the bridge have been prepared in a nearby quarry. The bridge project was the main activity of one of the two Italian forest rangers provided by FAO. He also constructed an improved access road to the gravel layers in the river bed and a solid river crossing for the gravel transport.

The two rangers also completed the measurement of the 20 compartments into which the demonstration forest has been subdivided and finished the map of the forest, which has since been reproduced for the preparation of the forest inventory and the working plan.

One of Mr. Gläser's main activities has been to supervise the training of forest workers, who had never before seen a saw or a file, in all phases of tree felling and logging work. They were at first trained in handling axes, crosscut and bowsaws and in the proper filing of raker toothed saws and other tool maintenance. Felling of trees was the next step, which was followed by the correct conversion of the felled trees into various assortments such as saw and veneer logs, railway sleepers, boxwood, fuel- and charcoal-wood, round and split. This training was difficult since the workers had never before had to cut timber for more than one kind of end-use at a time.

Near the headquarters for the project, a tree nursery has been prepared and fenced, and stables for horses and mules have been built.

• Elsewhere in the Caspian Sea region the Forest Service has, with the financial help of the United States technical assistance program, established on several private properties demonstration areas to show farmers the advantage of well-managed pastures and forests. One of these areas, the Hassan Abad demonstration on the northern slopes of the Elburz mountains, consists of 600 hectares of which 10 hectares are poor range land and 590 hectares badly exploited conifer forest (*Cupressus sempervirens*) with large gaps. The range has been reseeded with valuable fodder grasses, and gaps in the lower part of the forest have been planted with *Pinus eldarica* and walnut. The whole area is fenced to foster natural regeneration of the *Cupressus*. Fencing, reseeding of the range and planting of *Pinus* and walnut are paid for by the Forest Service. The owner has nothing to pay. Practical demonstration areas of this kind convince the farmers much better than any amount of talk.

Mr. P. Bedard is now the I.C.A. forester in Iran.

Ireland

• On the occasion of last year's meeting of the British Association for the Advancement of Science in Dublin, members of the Forestry Section made a number of excursions to State forests and places of arboricultural interest in the county of Wicklow. One such visit was to the Glenealy Forest near the coast, where the striking trees are the Eucalypts. A number of small trial plots of various species were established here between 1934 and 1937. The best species is *Eucalyptus johnstoni* but *E. urnigera*, *E. dalrympleana*, *E. gigantea* and *E. radiata* have all done well. None of these suffered seriously in the exceptional winter 1939-40, although a number of other species did. Growth has been most impressive, and groups dominating all the trees around them have survived some very severe winds.

On another forest, *E. viminalis* and *E. muelleri* had been planted at wide

spacing between " Anderson " groups of oak, ash, etc., in oak coppice. The eucalypts are now about 80 feet (20.6 m.) in height, very much larger than the hardwoods in the planted groups.

Israel

• In semiarid and arid areas, experience has shown that both survival and early growth after setting-in are greatly enhanced by using balled nursery stock for afforestation. The question, however, arises as to the most suitable raw material, type and size of containers. Experiments on these problems, sponsored by FAO and the International Union of Forest Research Organizations (IUFRO), have been entrusted to the Forest Research Institute, Ilanoth.

It is now possible to report the preliminary results of tests with the production of balled eucalypt stock. The choice of eucalypts is justified by the world-wide importance for afforestation of trees of this genus. Further tests including both conifers and hardwoods are under way. It is hoped that full results can be published within the next three years.

Receptacles of different types, both locally made and received from abroad, have been included in the tests, provided sufficient quantities (at least several hundreds) were available.

The containers were laid out in randomized blocks with two replicates, in rows one meter wide. The soil used for filling-in was a red loamy sand of pH 6.5. Overhead irrigation was applied by stationary nozzle lines, 0.9 meter above the ground, parallel to the rows of receptacles; the amounts of water applied were measured by water-meters attached to the oscillating motor at the head of the line, and occasional checks of efficiency and distribution pattern were carried out with spray gauge cans.

The transplanting of the eucalypt seedlings, about 5 weeks old, took place in mid-June; beating-up of failures was carried out with the same seedlings within three weeks after transplanting. Irrigation water was applied according to need, the total amount during the six months trial ranging from 12,000 to 13,000 cubic meters per hectare. In addition to weeding by hand, combined top and root prunings were carried out at least once (usually three to four times) whenever root growth into the soil underneath the containers had taken place and the tops of the saplings outgrew a mobile wooden frame, 38 centimeters high.

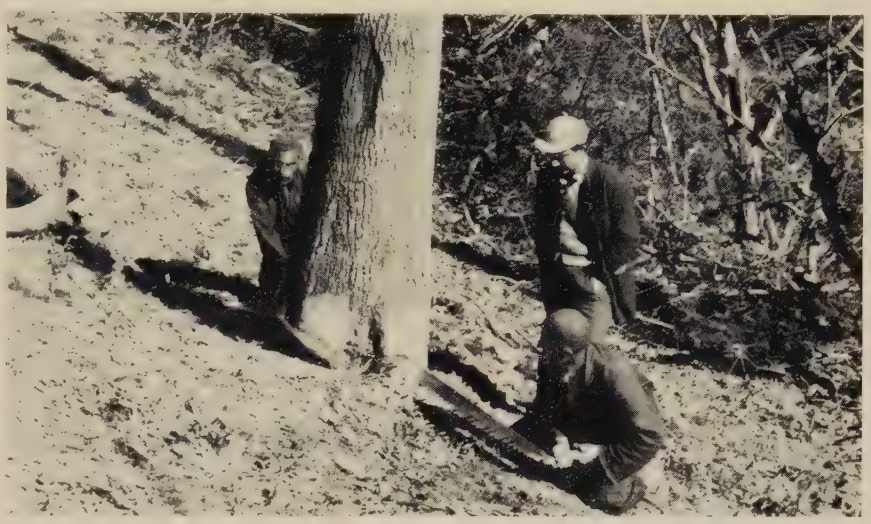
The peak of the planting season in Israel being in mid-December, the saplings were grown in the nursery until 15 December. Then, saplings for laboratory analysis were sampled at random by using Fisher and Yates' tables of random numbers. Transplants growing single in pots or tubes were sampled by random selection of 4 × 25 plants from each type of container and replication. In case of several transplants grown together in large receptacles, a double sampling technique was evolved; after random selection of a sufficient number of receptacles from each replication, 4 × 25 transplants for analysis were sampled at random. In addition, the rates of survival of the transplants were noted.

In the laboratory, the roots of the saplings were washed carefully in order to remove soil fragments; then, the transplants were dried at 65° C during 24 hours. The tops (including leaves) and roots of each subsample of 25 plants were weighed separately and the top root-ratio was calculated. The weights and top root-ratios were used as criteria for determining the quality of the transplants and respectively the suitability of the receptacles.

The best results have so far been obtained when nursery stock of *E. camaldulensis* was raised in earthenware or concrete pots. The size (weight) of the transplants appears to be related to the volume of soil available for root growth.

Development of transplants raised in large receptacles is poor owing to over-crowding and root competition, although the volume of soil per transplant is by no means negligible.

Although good results were also obtained by raising saplings in large-sized black polythene (Fitocelle, Catania) bags, the volume of soil contained in these bags is considered excessive; trials are now under way with smaller-sized Fitocelle bags. Tests with locally produced polythene bags show that the thickness of the material should exceed 0.025 millimeters. Plants in tar paper tubes were of



IRAN: **Above.** *Construction of the forest road to the Lowe demonstration forest described on page 150.*

Below. *Forest workers learn to use a cross-cut saw to fell an oak.*

poor quality, and it is believed that mineral tar exerts an inhibiting effect on root growth.

Provided both top and root pruning are carried out properly, the weights of the top (T) and root (R) as well as the top/root ratios (T/R) are suitable for assessing the quality of transplants raised in various containers. Transplants with high T values have thick, sturdy and well-hardened stems and are most suitable for planting.

No final conclusion can be drawn from the investigations carried out so far, as additional evidence is required for assessing conclusively the quality of transplants as well as the suitability of various receptacles. In addition to silvicultural characteristics, data are required with regard to the expenses involved in using various containers, i.e., cost price, costs of handling in the nursery, transport costs and service life.

Japan

• Expanded reforestation is a new forest policy to be followed in Japan which, in addition to the reforestation on cut-over and denuded land, aims at changing the uneconomic natural broadleaved forests with low rate of growth into more valuable plantations of coniferous and other species with higher annual increment.

Malaya

• Two newspaper clippings received from Malaya are of interest. The first reports that a prefabricated classroom of pressure impregnated timber, designed by the Forest Department, has given such useful service since its first appearance two years ago that 135 are now in use all over the Federation. A spokesman for the Education Department said that these classrooms had more than proved their worth. They were light, cool, comfortable and only about two thirds of the cost of a brick classroom of the same size. Perhaps their greatest advantage is the fact that their sectional construction facilitates very quick erection and demolition. They have a floor space of 22 by 30 feet, asbestos roofs, softboard ceilings and large areas of windows. They are designed to last for 25 years.

On the other hand, the failure of the " people's house ", designed as a cheap timber dwelling by the Forest Department three years ago, is apparently due to the fact that the people it was designed for and the building societies who could have helped them buy it, had outdated ideas about timber.

The traditional Chinese of the new villages, for whom the house was primarily designed, objected to it on religious grounds because it did not possess the usual symmetrical front door flanked by a window on either side, and because they claimed that good luck would fly out of the house. But the majority of people were biased because of their conviction that timber buildings were prone to termite attacks and doomed to a short life. They could not be convinced that the pressure impregnated timber used in the construction of the " people's house " was designed to withstand these attacks and to last for at least 50 years.

Building societies were equally reluctant to consider the advantages of the dwelling on the same grounds, and they also claimed that the fire risk in timber houses was too great. Consequently, even those prospective buyers who might have been interested in acquiring the house failed to obtain a loan from a building society. A spokesman for the Federation fire services said that there was no more risk of fire in a timber dwelling than in a brick one. It depended entirely on the attitude of the house-owner.

Pakistan

• In East Pakistan, the Chittagong Hill Tracts, with a total area of about 5,500 square miles (14,245 km²), form the catchment areas of all the rivers flowing through the plains district of Chittagong. About 1,000 square miles are reserved forests and the rest mostly " unclassed state forests " subject to uncontrolled shifting cultivation by local tribes. Owing to the very friable nature of the soil and the torrential rainfall during the rainy season, this " jhum " area (shifting cultivation is known locally as " jhumming ") is subject to sheet erosion both before and after the sowing of the crops; the crop cover is too sparse to offer any substantial barrier to the water run-off.

Even 15 years ago the average yield of paddy per acre amounted to 15 maunds (1,383 kg. per ha.), but as a result of increased population pressure on lands already seriously reduced in area by land slips on steep hills, the yield has decreased to about 8 maunds per acre (738 kg. per ha.). Cultivation on short rotations of 3 to 6 years has resulted in the retrogression of the evergreen forest, sometimes into a savanna type land covered with *Imperata* grass, *Eupatorium odoratum*, inferior quality bamboos (*Melocanna bambusoides*) and wild plantain. This ecological retrogression is a considerable factor in the soil erosion and uncontrolled run-off from the unclassed state forest. The *Imperata* grass makes the whole area subject to fire, set accidentally or intentionally to get a new flush of leaves for the cattle.

Some years ago, a first measure to discourage the movements of the tribal people was to establish a village jurisdiction, and get the people to remain within the fixed area of this " mouza ". Members of one " mouza " were not prevented from practising shifting cultivation in the jurisdiction of another " mouza ", but they had to pay tax at a fixed rate per household to the headmen of both " mouzas ". This double taxation tended to induce them to remain within one " mouza " only. Beyond that, the uniform rate of taxation, on a household basis, irrespective of the area of land cultivated, encouraged the cultivation of larger single areas every year instead of scattered plots, thus lengthening the period of fallow between clearings.

An FAO officer reports that the Soil Erosion Board set up for the district of the Chittagong Hill Tracts proposes to regulate shifting cultivation by confining the practice to compact blocks of forest on a prescribed rotation, with a minimum of 10 years, and insisting on precautions against the spread of fire when the plots are burned in the hot weather season.

Cultivation of river banks and steep slopes would be forbidden. Strips of forest should be maintained along both banks of rivers.

It has been suggested that the lower hills be terraced by means of tractors, and that the tribesmen (some 250,000 people) should be instructed to cultivate this land with the plow.

• The Pakistan Industrial Development Corporation are reported to have appointed a Vancouver firm as advisers on the development of one million acres in the Sunderbans area of East Pakistan. They are to assess the amount and type of timber in the area and to provide means of extraction, using the rivers to carry the timber to the pulp and paper mill which is to be built at Khulna. To assist in this work, an aerosurvey company has just completed its study of the area. Photography was carried out at two scales, 1/30,000 and 1/15,000, using two cameras simultaneously, one with a 6-inch and one with a 12-inch lens. The smaller scale photography will be used for topographical mapping and the larger scale for photographic interpretation and the preparation of a forest inventory.

Poland

• The reduction of the forest area in Poland came about originally by the increase in the population, agricultural expansion on the lowlands, and extension of grazing in the mountainous regions. At the end of the 18th century the forest area was reduced to about 37 percent of the country. Throughout the 19th and the early 20th century deforestation continued, chiefly on privately-owned holdings due to clear felling, neglect of subsequent regeneration and conservation practices, fragmentation of forests in liquidating servitudes, and the building of summer resort dwellings. In the western parts of the country the ratio of the forest cover was reduced from 21.5 percent in the 19th century to 20.7 percent at the beginning of the 20th century; in the southern parts the figures declined from 28.7 percent to 25.4 percent; and in the central and eastern parts from 30.4 percent to 19.2 percent. For the country as a whole (boundaries prior to 1939) the figure of forest cover ratio decreased from 28 percent to 22.2 percent respectively. As the result largely of extensive afforestation, the percentage had increased by 1955 to 23.8 percent. However, at the same time an adverse process was at work owing to the large-scale development of the mining industry.

A report to FAO describes the actual area of land under forest and tree cover as insufficient. A program for increasing the forested ratio up to 26.6 percent (by 1975 up to 25.5 percent) is under way. The entire program on public land will be financed by the State and on private land will be carried out at the cost of the owner with State assistance in seed, planting stock and competent technical assistance.

Southern Rhodesia

• The last annual report of the Southern Rhodesia Forestry Commission records with some pride exploitation from the Stapleford Forest Reserve in the Eastern Districts.

In 1956/57, 202 acres (82 ha.) of pines were clear-felled yielding 993, 300 cubic feet (28,130 m³) over bark of timber, the bulk of which was in the form of sawlogs. Extraction from thinned areas yielded 407,100 cubic feet (11,530 m³) over bark of timber, three-quarters of which was saw timber and most of the remainder pulpwood billets. The total volume extracted of 1,400,400 cubic feet (39,660 m³) when compared with the 800,000 cubic feet (22,656 m³) extracted during the previous year, gives an indication of the increasing scale of exploitation on the Reserve.

Felling in clear-felling areas was largely done very successfully with power chain saws operated by trained Africans. Wherever possible extraction from clear-felled areas was done by tractors but Wyssen cables or tractor winches were used to bunch logs in difficult country. Tractors were also used to haul logs from stump to roadside in areas of third thinnings, whilst smaller thinnings were dealt with by a combination of light tracked tractors and oxen. Loading at roadside was done on an increasing scale by winches but hand labor was used to augment these.

The direct labor cost of extraction from clear-felled areas fell from 0.9d. to 0.47d. per cubic foot and the output per man/day unit rose from 46.2 to 118.5 cubic feet. (1.35 to 3.33 m³) In thinned areas equivalent costs fell from 1.18d. to 0.91d. per cubic foot, and output per unit increased from 31 to 51 cubic feet (0.87 to 0.44 m³).

The direct labor cost of loading logs from clear-felled areas dropped from 0.32d. to 0.24d. per cubic foot and the output per unit rose from 136 to 242 cubic feet (3.84 to 6.84 m³) The direct labor cost of loading from thinned areas remained unchanged, but output pe runit rose from 146.7 cubic feet to 180.2 cubic feet (4.14 to 5.14 m³).

Whereas the Stapleford Forest exploitation account for the previous year showed a deficit of £6,700 there was a profit of £5,800 on the 1956/57 working, after allocation of overhead expenses.

Sudan

• A report to FAO on the land-use situation in the Sudan divides the country into regions as shown in the following Table.

The woodland savanna, the report says, may be divided into two zones — a dry savanna and a wet savanna. In the dry savanna the rainfall varies between 300 to 900 millimeters. The soil is of two major types — sandy soils west of the White Nile and clay soils east of it. Agricultural development on the clay soil is extensive in this area. Pump schemes extend along the Blue Nile on both banks as far south as latitude 12° 30'. On the White Nile, pump schemes are extended further south. On the areas where the rainfall is between 500 to 700 millimeters extensive mechanized grain production dependent only on rainfall has been embarked on, and the area is being gradually extended. American cotton is also grown in certain parts of this area on rain only. Rice cultivation was recently introduced in areas along the banks of the White Nile, but there is no organized production on a large scale.

Shifting cultivation is more intensive on the clay than on the sandy soils. On the clay, in addition to grain, large quantities of sesame are produced. On the sandy soils, ground nuts are extensively grown, together with grain and sesame.

The major difficulty in using these extensive areas of clay and sandy soils where the rainfall is sufficient for crop production, is the domestic water supply at the time of ripening and harvesting the crop. This difficulty has in part been overcome by making surface reservoirs (*haffirs*) for storing water. Through such *haffirs*, large areas which were formerly closed to grazing owing to the lack of water, are now utilized.

The forests of this region may be divided as follows:

(*a*) *Acacia mellifera.* This species is found where the rainfall does not exceed 500 millimeters on clay soils. Some areas have been reserved for charcoal and firewood production.

(*b*) *Acacia arabica.* These forests reach their southernmost limit in this region, i.e., south of latitude 12° N. Along the Blue Nile, Dinder and Rahad rivers,

SUDAN: LAND-USE SITUATION ACCORDING TO REGION

Region	Area		Rainfall, mm.	Percent
	Sq. miles	Km²		
Desert	280 000	(725 200)	0– 75	28.94
Semidesert	190 000	(492 100)	75– 300	19.62
Woodland savanna	400 000	(10 360 000)	300–1600	41.34
Flood region	95 000	(246 000)	700–1600	9.86
Montane vegetation	2 500	(6 475)	500–2000	0.24
TOTAL	967 500	11 829 775		100.00

most of them have been reserved, but only those of the Blue Nile have been put under planed management for sawn timber production (for sleepers). Many of the forests on the Dinder and Rahad have been exploited for this purpose and have been regenerated after felling.

(*c*) *Acacia seyal.* This species is by far the commonest on clay soils in this region. It yields a valuable gum which is inferior to gum arabic. The wood is usually used for charcoal production. It is not valued as pole because it is very susceptible to insects (borers). Large areas of this type have been reserved.

(*d*) *Acacia senegal.* This is limited to small groups and sporadic trees scattered in the above zone, but where the rainfall is between 500 to 700 millimeters.

(*e*) *Combretum, Terminalia, Anogeissus, Albizzia sericocephala.* This forest is confined to the sandy soils where the rainfall is over 450 millimeters. A new railway has been extended westwards in this region and planned, large-scale, mechanized crop production is being considered. Not much forest reservation has been carried out, but plans are under way. This is also an important grazing area.

In the wet savanna, the rainfall varies between 900 and 1,600 millimeters. Clay soils with *Acacia seyal* are not uncommon in the northern parts of this zone. *Combretum, Terminalia, Anogeissus,* etc., are found on the lighter soils. On the ironstone soils which are found further south, *Isoberlinia* dominates, with *Khaya senegalensis* in certain areas. In the southernmost region with the highest rainfall, closed savanna occurs, recently derived from rain forests through the agency of fires. Valuable species such as *Chlorophera excelsa, Khaya grandifolia, Daniellia oliveri, Maesopsis eminii* are found.

Forestry activities in this region are fairly extensive. There are three groups of sawmills. The logs utilized do not necessarily come from reserved forests, but forest reservation is going on rapidly. Formation on exotic plantations, mainly with teak on plain and valley soils, is taking place.

Grazing in this area is fairly extensive. The southwestern corner of the country is excluded, due to the prevalence of sleeping sickness.

Shifting cultivation is practised throughout the region. The main crops are groundnuts and grain. Tobacco and rice are also cultivated. Coffee occurs naturally in some of the forests, but fairly large plantations have been successfully established. Tea plantations are being considered and experiments are being carried out.

There are two important zones of montane vegetation. In the south-eastern Sudan there are the mountain masses of the Imatonga rising to over 10,000 feet (3,000 meters), the Didinga and the Dongotona hills. The main land use activity in this area is forestry. Conifers are planted. *Coffea arabica* as opposed to *C. robusta* which is planted in the western parts, is successfully established. Tea plantations are also being considered. Shifting cultivation is practised on gentle slopes and valleys.

In the western Sudan there is Gebel Marra, rising to over 10,000 feet, (3,000 meters). There are perennial streams and fertile volcanic soils. Terraced, irrigated cultivation on the hill slopes is practiced. The people grow wheat, red pepper and other grains. The growing of citrus trees is becoming common in this area. Large-scale forestry activities and organized irrigation with reservoirs, etc., is under consideration.

United States of America

• A report (Technical Bulletin No. 1139) of the Department of Agriculture deals with the biological control of insect pests in the United States, primarily the pests of agricultural crops but also the pests of forest and ornamental trees.

Most of the pests are of foreign origin. The first intentional importation of an insect enemy of a crop pest was in 1884, but real biological control work began four years later. Since that time the search for natural enemies of pests has covered the entire world, and successfully introduced, effective parasites, now numbering 95, have come from western Europe, Australia, southeast Asia and South Africa, with a few from South America. In addition, various native predators which originally were blocked by various barriers from spreading have now been successfully introduced in some parts of the United States.

With the introduction of new insects, some complex problems have arisen about the effects of insecticides not only on the pests but also on the predators. There is no general or simple answer to this relation.

As to forest trees, success has been attained in relation to the gypsy moth, brown-tail moth and satin moth, all of which are introduced and all of which have caused great damage to forest and shade trees in the eastern United States. In all these cases, the level of control by the predator is by no means complete but is sufficient to be very much worthwhile.

The publication includes not only a very comprehensive bibliography but a full summary of knowledge to date on the established parasites and predators which may have applicability elsewhere.

• After many years as a valueless weed tree with limited industrial use, lodgepole pine (*Pinus contorta*) has recently come into greater use for poles, pulp and lumber, particularly in the four Rocky Mountain States of Montana, Idaho, Wyoming and Colorado, which contain 80 percent of the total volume of the species. A recent study of lodgepole pine for sawn lumber shows that commercial production has risen from insignificant figures to about 200 million board feet per year, but this is still only one fifth of the allowable cut. Even so, the com-

TURKEY: *To commemorate the centenary of forestry teaching in Turkey, a special series of stamps was issued by a joint collaboration between the Ministry of Communications and the Ministry of Agriculture in November 1957. Only 500,000 sets were released in the two designs shown heve.*

Four banderoles attached to the stamps read as follows: "Forests are indispensable gifts and invaluable ornaments of the earth." "A country without forest is not a motherland. Ataturk." "Forests are an insurance for agriculture." "Forests and water are the sources of life."

petitive position of lodgepole pine against other western species is improving and in one sample the average price of lodgepole was nearly 10 percent below that of competitive species.

The position can be improved by reducing manufacturing costs, especially by using small sawmills particularly designed for handling small logs, by increasing the lumber recovery and possibly by gluing up narrow boards to make wider stock which carry a higher price in the markets. In total, the once-despised species has now fully established itself.

• *Wood for Marine Use and its Protection from Marine Organisms*, (ASTM Special Technical Bulletin No. 200, The American Society for Testing Materials, 1916 Race St., Philadelphia 3, Pa., 52 pp.) contains papers presented at a technical session of the Second Pacific Area National Meeting held in Los Angeles, California, on 17 September 1956. Four individual papers deal with: the distribution and importance of marine wood borers in the United States; marine exposure tests of wood treated with various preservatives; performance tests of heavy metal compounds; and the relationship between limnoria species and service life of creosoted piling. A bibliography is included, designed to make available to engineers a cross-indexed list of the important and more recent comprehensive papers dealing with biologic and ecologic aspects of marine borers and to illustrate the variety in the kinds of known boring organisms and the diversity of the substances into which they penetrate. The bibliography has been divided into three parts: first, an annotated list of references by authors; second, a general systematic index to the organisms; and third, an index of the major kinds of substances which have been attacked by borers.

Together, the papers are intended to present a picture of marine borer problems and the difficulties encountered, the results of some special research studies on the nature and distribution of certain organisms, the most susceptible zone of attack and the effectiveness of certain specific protection procedures.

Yugoslavia

• One of a series of technical assistance missions carried out recently in Yugoslavia concerned forest inventory methods.

The specialist engaged by FAO considered that a country-wide forest inventory would not be very costly. In Sweden, the complete national forest survey costs less than two dinars (5 cents) per year per hectare. This very reasonable figure is partly explained by the fact that the Swedish terrain is fairly even and the forest areas are very concentrated. A Yugoslav national forest inventory would be somewhat more costly, varying from perhaps 5 to 10 dinars per hectare per year due to the special difficulties created by the steep terrain and the scattered forest areas. The costs of the working plans on which present inventories are based, amount to about 500 to 1,500 dinars (U.S.$1.20 to $3.75) per hectare.

Including the changes to be envisaged in planning methods, the total costs of instruments to be bought and aerial photographs to be taken, it is safe to assume that considerable savings would be possible once new methods had been applied for one or two years and the work was thoroughly organized. Costs are considerably influenced by the way field work is organized. Every effort should, therefore, be made to reduce field work costs to a minimum without sacrificing the degree of precision required by the survey. In this connexion, the demonstration inventory is of considerable importance. The costs of a demonstration inventory should be regarded as a necessary research expense and as an investment that will eventually yield good dividends.

Book Notices

The Outlook for the Canadian Forest Industries. The Forestry Study Group, Royal Commission on Canada's Economic Prospects. 261 pp. 1957.

The Outlook for the Canadian Forest Industries reports the analyses and findings of a Forestry Study Group specially appointed by the Royal Commission on Canada's Economic Prospects. It estimates that the overall consumption of timber in Canada by 1980 will have increased by 57 percent over 1954.

Canada's vast forest area of 1.5 million square miles (3.9 million square kilometers), extending westward and northwestward from Newfoundland on the Atlantic coast to British Columbia and the Yukon Territory on the Pacific, covers more than two fifths of the total land area of the country. Of the commercially productive forest area, which alone makes up almost one quarter of the total, softwood species comprise about four fifths.

Estimates of "allowable cut" in the various forest areas, provided to the Commission from government sources, indicated a potential available supply in 1980 of 9.5 thousand million cubic feet (270 million cubic meters) — 7.3 thousand million cubic feet (210 million cubic meters) from accessible forest lands, with another 2.2 thousand million cubic feet (60 million cubic meters) from potentially accessible areas.

The Table below shows estimated demands of Canada's wood-using industries in 1980 compared with actual utilization in 1954.

Pulp and paper production, the study group believes, may more than double over the next quarter century. Increased wood requirements of Canadian mills are likely to result in a leveling off or even a decline in pulpwood exports. The products structure of the industry, however, is expected to change little: newsprint and market woodpulp, which together accounted for some 83 percent of the 1954 industry output, are expected by 1980 to make up 81 percent of output. Dealing with newsprint, the report estimates that world newsprint re-

ESTIMATED DEMAND, 1980 *Versus* UTILIZATION, 1954
(in millions of cubic feet)

Type of demand	1954	1980	Percentage change
Wood for domestic pulp and paper industry	1 100	2 120	+ 93
Logs for lumber and other sawn products	1 400	2 220	+ 59
Logs for softwood plywood and veneer	40	130	+225
Logs for hardwood plywood and veneer	20	30	+ 50
Pulpwood exports	160	150	— 6
Fuelwood	310	160	— 48
Miscellaneous roundwood			
Domestic	50	55	+ 10
Export	25	25	Nil
TOTAL	3 105	4 890	+ 57

quirements, 13 million tons in 1955, will double to 26 million tons by 1980. Canada, which supplied 59 percent of world requirements in 1950 and 47 percent in 1955, is expected to contribute about 44 percent of total newsprint needs in 1980.

If the forecasts put forward in the report are realized, the Canadian forest industries, as a group, will more than double in size over the next 25 years. An average annual outlay of from $300 million to $400 million will have to be maintained, compared with an average of $165 million invested by all of the forest industries there in recent years. By 1980, exports of forest products, the report expects, will approximately have doubled to reach a value of perhaps $2.9 thousand million, while output, also measured in constant dollar terms, may reach $4 thousand million, approximately 120 percent above 1955 levels. This, however, is a lesser rate than that envisaged (in the Commission's other staff studies) for the Canadian economy as a whole. As the latter may rise by approximately 200 percent, the forest industries contribution (as measured in terms of gross domestic product) may fall from around 5.5 percent to approximately 4 percent between now and 1980.

For more than a century Canada's forest industries have constituted a major sector of the national economy. That they will continue to play a leading role over the next twenty to thirty years there can be no doubt. Canada is in a favored position for industrial wood production because of its predominantly coniferous forests, its proximity to densely populated and prosperous industrial and agricultural areas to the south, and its supply of clear water and water power.

Forest Terminology. The Society of American Foresters. 3rd Edition, 97 pp., Washington 1958.

Earlier editions being exhausted, the Society of American Foresters has just published a third and further revised edition of *Forest Terminology.*

The United States Department of Agriculture issued its first publications on forest terminology in 1905 under the title *Terms used in Forestry and Logging.* The first edition of *Forest Terminology* dates only from 1944. It was compiled by 10 subcommittees, reporting to a general collating committee which made final decisions. A revised edition, containing more terms and improved definitions, was published in 1950.

The present edition has been felt necessary " to keep pace with new terms added to the professional literature by continuing expansion and intensification in forestry. " It has been compiled by the editorial staff of the Society, aided by special subject-matter consultants and a great number of voluntary helpers.

For certain terms the new terminology gives the different regions of the United States where they are used. A term which has a particular usage for instance in the United Kingdom is indicated by the abbreviation " U.K. "

Thanks to the co-operation of the Commonwealth Forestry Bureau, progress has been made in bringing into line American and British Commonwealth definitions. This is an important step towards establishing the Multilingual Forest Terminology on which the Joint FAO/IUFRO Committee on Terminology has been working for some years, and which will be a long and exacting task.

Feast and Famine. Lord Boyd Orr. 69 pp., illustrated. Rathbone Books. London 1957. 17s 6d.

The problem of getting food has changed and directed the whole history of peoples. For the earliest men, finding just enough food to keep alive was a full-time job. They followed the moving herds which themselves followed the moving seasons. When winter came in the north and the green stuff of life disappeared, quarry and hunter together moved south where plants still grew. Only when man learned how to sow and reap and so produce more than enough for his own needs did civilization become possible. Only then could he pay another man, with food, to devote time and energy to devising better tools. With better tools, the land was made more productive; more people were released from farming and could turn their minds to building houses, designing boats, making laws, learning to write, understanding the world they lived in.

In *Feast and Famine*, Lord Boyd Orr, first Director-General of FAO and Nobel Peace Prize winner, traces the development of man from early Neolithic times to the twentieth century, wholly in terms of his quest for food. He shows how the discovery of the New World was a by-product of the search for a shorter route to the Eastern spices, needed to disguise the taste of bad meat. He shows how in the last century a stimulating redistribution of the earth's population was brought about when famine in Europe drove millions to America, Australia, and Africa.

The author is also concerned with food itself: how plants make food and how man's body uses it; how science has improved the quality and quantity of food: with pests and irrigation, storage and distribution: with the problem of feeding the earth's rapidly growing population. Over 200 colorful illustrations document this chronicle of man's concern with the basic fact of all life — food.

Guide to the use of Forestry Abstracts. Revised and enlarged edition in English, French, German, Spanish. 78 pp. The Commonwealth Agricultural Bureaux, Farnham Royal, Bucks. 1958. 10s.

The main function of the Commonwealth Forestry Bureau at Oxford, one of the three international forestry bibliography centers of the world, is to act as an effective clearinghouse of information for scientists and research workers in forestry throughout the Commonwealth and, increasingly, throughout the world. To this end the Bureau is organized to scrutinize and abstract from all literature, in whatsoever language it may be published, that carries material of interest to forestry. The information is distributed in two ways, one of which is through its quarterly journal, *Forestry Abstracts*, which presents the essence of current world literature extracted from over 550 periodicals, 700 serials and innumerable miscellaneous papers, books, etc., and now (in its 19th volume) totals some 4,500 abstracts each year.

Abstracting journals, so essential in enabling those interested in the widening field of forestry to keep abreast of the rapidly increasing volume of literature on the subject, cover a specialized field in which the need for compression develops a high degree of abbreviations and conventions, notably in the details of documentation. As stated in the introduction to the first edition of the guide, which appeared in 1950, " they are high-precision tools and those who handle them need some instruction before they can use them to full advantage ".

The revised and enlarged edition prepared by the Commonwealth Forestry Bureau has, as the title indicates and in line with the policy adopted in translation of the Oxford System of Decimal Classification for Forestry, added a German text to its contents. Its various sections have been considerably enlarged, notably that on the key to titles of publications noticed, on abbreviations indicating the library source, and especially on transliteration, which has been expanded from Russian and Bulgarian to include notes on Cyrillic, Greek, Arabic, Persian and Urdu. Finally, a section has been added listing some useful equivalents and local measures.

FAO Forestry Division

FORTHCOMING PUBLICATIONS

Choice of Species (*Development Paper No. 13*)

This section of the World Forest Planting Manual deals with the factors which should guide the choice of tree species for planting on various sites. FAO has consulted the experience of experts in many parts of the world in this outline of the principles governing the successful establishment of forest plantations. A number of examples are included of the results of the introduction of certain species on specific sites.

Tropical Silviculture (*in three volumes*)

Volume I contains a general study of Tropical Silviculture which was begun following the successful sessions of the Tropical Silviculture Section of the Fourth World Forestry Congress at Dehra Dun in 1954. The extensive research of literature undertaken for this study was based on the papers which were invited for that session, according to outlines prepared by the FAO Forestry Division. The papers themselves are contained in Volumes II and III, and are reproduced in the original languages only.

Yearbook of Forest Products Statistics 1958

Contains statistics from more than 100 countries on production, trade and consumption in roundwood, sawnwood, sleepers, plywood, woodpulp, paper etc., in addition to estimates of world production of forest products commodities by regions. Trilingual (English, French, Spanish) edition in preparation.

RECENT PUBLICATIONS

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Report of the FAO/ECE International Consultation on Insulation Board, Hardboard and Particle Board held at Geneva, January 1957. In English. French and Spanish editions in preparation.

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The genus Populus today holds a very special place amongst fast-growing species by virtue of its wide distribution, its suitability for cultivation both inside and outside the forest and for the extensive range of products which it yields. This study was prepared at the request of FAO by the standing Executive Committee of the International Poplar Commission.

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